National Institute of Technology Karnataka, Surathkal

An Institute of National Importance



2026
UNDERGRADUATE CURRICULUM

Regulations, course structures and detailed syllabi for the eleven B.Tech. programmes of the Institute

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA

SURATHKAL

(An Institute of National Importance under the Ministry of Education, Government of India)

U N D E R G R A D U A T E

C U R R I C U L U M

2 0 2 6

Bachelor of Technology (B.Tech.) Programmes

Academic Regulations • Course Structure • Detailed Syllabus

Surathkal, Mangaluru – 575 025, Karnataka, India

ACADEMIC REGULATIONS

The academic regulations are available on the Institute website: https://www.nitk.ac.in
Curriculum: https://www.nitk.ac.in/Curriculum

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MOTTO

Work is Worship.

VISION

To facilitate transformation of students into good human beings, responsible citizens and competent professionals, focusing on the assimilation, generation and dissemination of knowledge.

MISSION

Impart quality education to meet the needs of profession and society, and achieve excellence in teaching-learning and research.

Attract and develop talented and committed human resources, and provide an environment conducive to innovation, creativity, team-spirit and entrepreneurial leadership.

Facilitate effective interactions among faculty and students, and foster networking with alumni, industries, institutions and other stake-holders.

Practice and promote high standards of professional ethics, transparency and accountability

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Abbreviations

AP	:	Academic Programs
BoG	:	Board of Governors
BoS	:	Board of Studies
Dean (ACR)	:	Dean of Alumni & Corporate Relations
Dean (AP)	:	Dean of Academic Programs
Dean (FSW)	:	Dean of Faculty & Staff Welfare
Dean (IPD)	:	Dean of Infrastructure, Planning & Development
Dean (R&I)	:	Dean of Research & Innovation
Dean (SW)	:	Dean of Students Welfare
DAAB	:	Departmental Academic Appeals Board
DPGC	:	Departmental Postgraduate Committee
DRPC	:	Doctoral Research Programme Committee
DUGC	:	Departmental Undergraduate Committee
FA	:	Faculty Advisor
HoD	:	Head of the Department
IE	:	Incomplete End-Semester Exam
IKS	:	Indian Knowledge System
IRIS	:	Integrated Resource and Information Sharing
MoE	:	Ministry of Education
MOOC	:	Massive Open Online Courses
MOU	:	Memorandum Of Understanding
NADAL	:	NITK Academy for Defence, Adventure and Leadership
NC	:	Not Complete
NCC	:	National Cadet Corps
NSS	:	National Service Scheme
PG	:	Postgraduate
SA	:	Shortage of Attendance
UG	:	Undergraduate

PREFACE

The National Institute of Technology Karnataka, (NITK) Surathkal, established in the year 1960, is an Institute of National importance in the country, set up with the objective of imparting education, conducting research, and training in various fields of Science, Technology and Management. The Institute is now recognized as one of the top higher education institutes in the country and worldwide. It has evolved into a premier centre for education and research, guided by a vision to generate transformative ideas and advance innovations in science and technology. The Institute is dedicated to the creation, dissemination, and application of knowledge through quality education, research, innovation, industry and societal collaboration, and an unwavering commitment to professional ethics, transparency, and accountability, with the objective of developing competent professionals and responsible citizens.

The Institute on an average annually admits more than 1100 candidates for the undergraduate programmes (B.Tech.) through the Joint Entrance Examination (JEE), more than 1200 candidates for postgraduate Programmes (MTech/MTech(R)/MSc/MBA) through national level competitive exams such as GATE/NET/CAT/MAT/CMAT (as applicable) and around 190 candidates for Ph.D. programmes. The Institute follows a credit-based semester system. There are two semesters in an academic year (Odd: July- Nov; and Even: Jan-May) during which all courses specified for various degree programmes are offered. In addition to the two regular semesters, the Institute may offer a Summer Session for the conduct of summer courses. Students shall satisfy the prescribed academic requirements in each semester or Summer Session, as applicable. This document provides comprehensive information on the Rules and Regulations for B.Tech. Programme.

The Institute provides its academic departments the flexibility to design and offer academic programmes suited to their disciplinary requirements within the framework of the Rules and Regulations approved by the Senate from time to time. In keeping with emerging technological advancements and to provide students greater flexibility in pursuing their academic interests, the Institute has revised its undergraduate curriculum with effect from the Academic Year 2026–27. The revised curriculum offers academic flexibility and learning opportunities, enabling students to customize their educational experience. To derive maximum benefit from these provisions, students are expected to plan their academic programme carefully. Students and their parents/guardians are therefore advised to familiarize themselves with the Institute's academic regulations, particularly those relating to registration, assessment, grading, and academic performance requirements.

The Institute provides its students with an enabling environment and exceptional opportunities to develop into accomplished engineers, scientists, researchers, designers, economists, social scientists, and entrepreneurs. The Institute encourages students to make the best use of these resources to realize their full potential and contribute meaningfully to the profession and society.

We wish all our students a very bright future and a successful career.

Dean (Academic Programs)

1. Introduction

The Institute has 17 academic units (departments, schools and centres) which offer various Undergraduate, Postgraduate and Ph.D. Programmes.

At present, the Institute offers eleven B.Tech. programmes across diverse engineering disciplines. The first-year curriculum provides a strong foundation in basic sciences, including Mathematics, Physics and Chemistry, along with introductory engineering courses such as Engineering Design, Prototyping and Computer Programming. In addition, life-skill activities form an integral part of the curriculum, fostering students' Physical, Cultural, Technical and Professional development through sports, cultural activities, technical activities, and communication-skills development.

Departmental courses (core and electives) constitute about half of the total curriculum. Further, students are open to do inter-disciplinary elective courses from other departments to broaden the knowledge base or specialize in areas outside the parent discipline. The curriculum is designed to provide a strong academic foundation while cultivating innovation, critical thinking, adaptability and a commitment to lifelong learning.

The Institute also offers postgraduate programmes leading to the M.Tech., M.Tech. (Research), M.Sc., M.B.A., and Ph.D. degrees through its Departments, Schools, and Centres. A comprehensive portfolio of postgraduate and doctoral courses is offered and periodically updated to meet evolving academic and research needs. Students at both the undergraduate and postgraduate levels are encouraged to broaden their academic horizons by pursuing interdisciplinary courses and approved MOOCs (e.g., NPTEL/SWAYAM), in accordance with the applicable academic regulations.

The medium of instructions at this Institute is English.

1.1 Academic Units

Each course is offered by an Academic Unit which could be a Department, a Centre or a School. The names of the academic units and their two-letter codes are given in Table 1.

Table 1: Academic Departments, Centres, and Schools

Sl. No.	Name of Academic Unit (alphabetical order)	Academic Unit Code
1	Chemical Engineering, Department of	CH
2	Chemistry, Department of	CY
3	Civil Engineering, Department of	CE
4	Computer Science and Engineering, Department of	CS
5	Design and Entrepreneurship, Department of	DE
6	Electrical and Electronics Engineering, Department of	EE
7	Electronics and Communication Engineering, Department of	EC
8	Information Technology, Department of	IT
9	Inter-disciplinary Studies, Centre for	IS
10	Humanities, Social Sciences and Management, School of	SM
11	Mathematical and Computational Sciences, Department of	MA
12	Mechanical Engineering, Department of	ME
13	Metallurgical and Materials Engineering, Department of	MT
14	Mining Engineering, Department of	MN

15	Physical Education and Life-Skills, Department of	PL
16	Physics, Department of	PH
17	Water Resources and Ocean Engineering, Department of	WO

In addition to the academic departments offering degree programmes, the Institute has several Centres, Centres of Excellence, the Central Library and other academic support units that promote and support teaching, research, consultancy, innovation, entrepreneurship and related academic activities.

1.2 Organizational Structure for Academic Administration

The academic programmes of the Institute shall be governed by the Senate, the highest statutory academic body of the Institute. The Senate shall formulate, review, and approve the academic rules, regulations, curricula and policies governing all academic programmes. The decisions of the Senate, chaired by the Director, shall be final on all academic matters. The Senate shall also approve the Academic Calendar, which prescribes the schedule for all academic activities during the academic year.

The Senate shall periodically review and update the academic programmes through the Board of Studies (BoS). The Dean (Academic Programs), Assistant Registrar (Academic) and Deputy Registrar (Academic) shall serve as the Chairperson, Convener and Secretary of the BoS, respectively.

Academic matters relating to undergraduate, postgraduate and doctoral programmes shall be administered through the Departmental Undergraduate Committee (DUGC), Departmental Postgraduate Committee (DPGC) and Doctoral Research Programme Committee (DRPC), respectively. Each academic department, school or centre shall constitute these committees, with the Head of the Department (HoD) (or nominee) serving as the Chairperson, a faculty member as the Secretary and a few other faculty members as the members of the committees. These committees shall oversee curriculum implementation, academic progress, student performance and related matters, and make recommendations to the Senate through the BoS.

The Senate may also include student representatives as its members. Administrative support for all academic activities shall be provided by the Academic Section under the supervision of the Deputy Registrar/Assistant Registrar (Academic).

Upon admission, every student shall be assigned a Faculty Advisor (FA) from the parent department. Students must consult the Faculty Advisor on any matter relating to their academic performance and the courses they may take in various semesters/ summer sessions. The Faculty Advisor will guide the student in academic planning, course registration, monitoring academic progress and timely completion of the degree requirements, while providing advice on matters related to the student's academic development.

2. Academic Regulations

The Rules and Regulations of the undergraduate Degree Programme (B.Tech.) of the Institute, are presented here.

2.1 Scope of the Regulations

(a) The provisions contained in this set of Regulations govern the policies and procedures, on the admission of students, imparting instructions of courses, conducting of the examinations and evaluation and certification of students' performance leading to the said Degree Programme(s).

(b) Upon approval by the Senate, these Regulations shall supersede all corresponding earlier Regulations of the Institute and the amendments thereto, and shall be applicable to all students admitted to the undergraduate degree programme(s) from the Academic Year 2026–27 onwards.

(c) The Board of Governors (BoG) may, on the recommendation of the Senate change any or all parts of the Regulations at any time considered appropriate by the Senate.

3. Degree Programmes

3.1 Undergraduate (B.Tech.) Degree Programmes are offered in various disciplines by the respective programme hosting departments listed in Table 2 below:

Table 2: UG programmes offered by the Departments

Sl. No.	Hosting Department	B.Tech. Degree Programmes	B.Tech. Degree Code
1	Chemical Engineering	Chemical Engineering	(CH)
2	Civil Engineering	Civil Engineering	(CE)
3	Computer Science and Engineering	Computer Science and Engineering	(CS)
4	Electrical and Electronics Engineering	Electrical and Electronics Engineering	(EE)
5	Electronics and Communication Engineering	Electronics and Communication Engineering	(EC)
6	Information Technology	Information Technology	(IT)
		Artificial Intelligence	(AI)
7	Mathematical and Computational Sciences	Computational and Data Science	(DS)
8	Mechanical Engineering	Mechanical Engineering	(ME)
9	Metallurgical and Materials Engineering	Metallurgical and Materials Engineering	(MT)
10	Mining Engineering	Mining Engineering	(MN)
Participating Academic Units			
11	Chemistry, Department of		
12	Design and Entrepreneurship, Department of		
13	Humanities, Social Sciences and Management, School of		
14	Inter-Disciplinary Studies, Centre for		
15	Physical Education and Life-Skills, Department of		
16	Physics, Department of		
17	Water Resources and Ocean Engineering, Department of		

3.2 The provisions of these Regulations shall be applicable to any new disciplines that may be introduced from time to time and appended to the above list.

4. Admission

4.1 Admission to the B.Tech. programmes shall be governed by the rules, regulations and eligibility criteria prescribed by the designated admission authority under the Ministry of Education (MoE), Government of India, from time to time.

4.2 Admission to all courses will be made in the odd semester of each session at the first-year level based

on the relative performance in the Joint Entrance Examination Main (JEE-Main) and qualifying examination as per the guidelines issued, from time to time, by the MoE. The candidates should have successfully passed 10+2 examination with the combination of subjects prescribed by the Competent Authority.

4.3 A limited number of admissions is offered to Foreign Nationals and Indians living abroad in accordance with the rules applicable for such admission issued, from time to time, by the MoE.

4.4 The selected candidates shall be admitted to the B.Tech. programme after they fulfil all the admission requirements set by the Institute and after payment of the prescribed fees.

4.5 Student Exchange Programmes and the Transfer of Credits shall be as per the corresponding MOU approved by the Competent Authority.

4.6 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., the Registrar shall report the matter to the Senate, recommending revoking the admission of the candidate.

4.7 The Institute reserves the right to cancel the admissions of any student and ask the student to discontinue the studies at any stage of the degree program career on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

4.8 Multiple Entry-Exit under NEP2020

(a) The Institute shall implement the Multiple Entry–Exit provisions in accordance with the National Education Policy (NEP) 2020 and the applicable regulations as adopted by the Senate from time to time.

(b) After successful completion of the first, second, or third year of the programme and fulfilment of the prescribed credit and other academic requirements, a student may exercise the exit option and be awarded the corresponding qualification, namely a Certificate, Diploma, or Advanced Diploma, respectively.

(c) A student who has exited the programme under this scheme may be permitted to re-enter the B.Tech. programme within three years from the date of exit, subject to the prevailing regulations, curriculum requirements, availability of the programme, and such conditions as may be prescribed by the Institute. The Dean (AP) shall consider and decide such applications.

(d) Only one academic exit and one subsequent re-entry shall be permitted for a student during the duration of the programme.

4.9 Every Undergraduate student of the Institute shall be associated with Parent Department (Degree Awarding Department) offering the degree programme that the student undergoes, throughout his study period.

4.10 The decision of the Senate regarding the admissions is final and binding.

5. Academic Calendar

5.1 The normal duration of the course leading to B.Tech. degree will be EIGHT semesters.

5.2 The Institute follows a credit-based semester system and there are two regular semesters in a year. The semester that is typically from July to November is called the ODD SEMESTER, and the one that is from January to May is called the EVEN SEMESTER. The ODD and EVEN Semesters shall each normally be

of 17–20 weeks' duration, including the periods for evaluation and grade finalization. Each semester shall provide for at least 70 teaching days, with a five-day teaching week and at least 40 hours of teaching contact time per week. The academic calendar shall ensure, to the extent practicable, an equal number of instructional days for each weekday (Monday through Friday). During the summer vacation, i.e., (May-June), a few courses are offered as part of SUMMER SESSION. These courses can be taken by students as per summer session guidelines.

5.3 The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (AP), approved by the Senate, and announced at least TWO weeks before the Closing Date of the previous Semester.

5.4 Under any circumstances when any of the Teaching Days gets declared as a Holiday or otherwise when the classes get suspended, irrespective of whatsoever be the reasons, appropriate makeup for such loss shall be made by having the class/lab/teaching sessions conducted on a suitable Saturday by following the particular Class Timetable of that Teaching Day which was so lost.

6. Fee Payment & Registration

6.1 Every student shall complete the payment of the prescribed fees to be eligible for course registration within the period specified in the Academic Calendar. Failure to do so shall render the student ineligible to continue in the semester, unless otherwise permitted by the competent authority.

6.2 Every Student after consulting her/his Faculty Advisor is required to register for the approved courses in Odd/Even semesters, including Massive Open Online Courses (MOOC) with the approval of DUGC of Parent Department at the commencement of each semester on the days fixed for such registration and notified in the academic calendar. The registration to the courses is done in online mode through the Integrated Resource and Information Sharing (IRIS) platform of the Institute. Students are not permitted to re-register for course/(s), which they have already passed. Some courses may also require course instructor consent.

6.3 The first two semesters of the undergraduate programme shall normally consist of courses common to all disciplines. Every student shall register for all the courses prescribed in the curriculum for these semesters.

6.4 Lower and Upper Limits for Course Credits Registered in a Semester/Session

A student of the B.Tech. degree programme must register for a minimum of 9 credits, and up to a maximum of 30 credits including credits registered under the Honors, Minor (refer Clause No. 7.14), or approved Online Courses (refer Clause No: 7.7) categories. However, the minimum/maximum credit limit can be relaxed by the Dean (AP) on the recommendations of the DUGC, only under exceptional circumstances.

The maximum credits that a student can register in a summer session (refer Clause No: 6.10) is 16.

6.5 Course Registration and Drop Options

(a) **ADD-option**: A student has the option to ADD courses for registration till the last date for registration specified in the Academic Calendar.

(b) **DROP-option**: On recommendation of the Teaching Department as well as the Parent Department, a student has the option to DROP courses from registration before the deadline specified in the

Academic Calendar.

(c) **cU-option**: A student can register for auditing a course, or a course can even be converted from Credit to Audit or from Audit to Credit, with the consent of the Faculty Advisor and Course Instructor before the deadline specified in the Academic Calendar. However, CORE Courses shall not be made available for audit for the students of the parent Department.

6.6 All academic units shall announce the list of courses to be offered for the next higher semester, at least TWO weeks before the last day of classes in the current semester.

6.7 Undergraduate students may be permitted to register for postgraduate courses with the prior approval from the Faculty Advisor and DUGC of the parent department. However, students intending to register for postgraduate courses of other departments shall require additional approval of the course instructor.

6.8 Course Pre-Requisite

In order for a student to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses. In such instances, the DUGC shall specify clearly, any such course pre-requisites, as part of the curriculum.

6.9 A student shall be permitted to register for the next semester (Odd/Even) only if she/he:

(a) satisfies the academic requirements for continuation in the programme without temporary/permanent withdrawal (refer Clause No. 12);

(b) has cleared all outstanding Institute, Hostel and Library dues, including fines, if any;

(c) has paid the prescribed Institute and Hostel fees for the ensuing semester; and

(d) is not debarred from registration on disciplinary or any other grounds by the Institute.

6.10 Summer Session Course Registration

Running of courses in summer session and registration of students to these courses must follow the guidelines mentioned below:

(a) Registration for summer session is permitted for students with NC/SA grades only (refer to Clause No: 8.13), for courses of the first year and final year, subject to the approval of DUGC. The DUGC should recommend offering of such a summer course for consideration and approval of the Dean (AP). The course is offered on approval of the Dean (AP).

(b) A student who is eligible and wishes to register for the courses during the summer session must pay the applicable fee prior to the start of the summer session.

(c) The course should be offered with adequate rigor. The registration, examination and assessment, course duration and grading should adhere to the timelines in academic calendar.

(d) The dropping of a Summer Course is permitted within 7 days from the first lecture of the course. However, the fee is not refundable.

(e) The maximum credits that a student can register in a summer session is 16.

7. Course Structure

7.1 The curriculum of the B.Tech. programme shall consist of the course components specified in Table 3 below.

The minimum credit requirement for the award of the B.Tech. degree is 150-152 credits, distributed broadly among the various curriculum components as shown in table 3.

Table 3: Course Components of the B.Tech. Program and the associated Credits

Sl. No.	Category	Symbol	Credits	Remarks
1	Basic Sciences Courses	BSC	20	Courses in Mathematics, Physics, Chemistry, Biology & Environment, and Indian Knowledge system.
2	General Engineering Courses	GEC	12	Courses in Introduction to Engineering, Computer Programming, Data Science and AI, Design Thinking and Prototyping.
3	Life Skill Courses	LSC	20	Courses in Physical (Sports), Cultural, Technical and Professional (Comm.) skills and NCC.
4	Programme Core Courses	PCC	45 - 51	Programme Specific Core Courses.
5	Department/Institute Elective Courses	DEC	20 - 28	Department/Institute Elective Courses.
6	Internships/Major Project Courses	IPC	27	Department/Industry Internships and Projects.

7.2 The General Institute Requirement

The General Institute Requirement comprises a prescribed set of foundational courses and experiential learning components common to all B.Tech. programmes. Aligned with the objectives of NEP 2020, the curriculum emphasizes outcome-based, practice-oriented education through laboratory courses, multiple internships and project-based learning, enabling students to develop the knowledge, skills and competencies required for higher studies, research, innovation and professional practice. It also includes Life Skills courses designed to promote physical, cultural, technical and professional development. Together with the programme-specific curriculum, these components provide a comprehensive foundation in basic sciences, engineering fundamentals, interdisciplinary learning and professional competencies.

7.3 Each B.Tech. programme offered by the Institute shall have a curriculum and syllabi of courses approved by the Senate and the syllabus of any course gets modified/ updated by the Senate from time to time on the recommendation of the respective DUGC, and BoS.

7.4 Course Credit Assignment

Every Course comprises specific Lecture-Tutorial-Practical (L-T-P) Schedule. The Course Credits are fixed based on the following norms:

Lectures/ Tutorials: One hour per week is assigned one (1) Credit.

Practicals: (i) A 6-hour session per week is assigned three (3) Credits;

OR

(ii) A 2-hour session per week is assigned one (1) Credit;

OR

(iii) A 3-hour session per week is assigned 1.5 credits.

For example, a theory course with a L-T-P schedule of 2-1-0 will be assigned 3 credits; a laboratory practical course with a L-T-P schedule of 0-0-2 will be assigned 1 credit.

7.5 Programme Core Courses

Programme Core (PC) courses constitute the mandatory discipline-specific component of the curriculum and shall be successfully completed by every student enrolled in the programme. A student shall complete all the prescribed Programme Core courses (theory and practical courses) as specified in the respective programme curriculum, to fulfil the degree requirements.

7.6 Department/Institute Electives

The elective courses offered by the parent department constitute the discipline-specific choice-based component of the curriculum, enabling students to pursue advanced topics and specialized areas within their programme. These courses provide academic flexibility by allowing students to tailor their learning in accordance with their interests, career aspirations, and emerging technological developments. Departments typically offer a structured list of approved Programme Electives, from which students shall complete the required credits to fulfil the degree requirements.

To promote interdisciplinary learning and broaden their knowledge base, students may register for approved Institute Elective courses offered by other departments in lieu of the prescribed Programme Elective courses.

7.7 Online Courses

Students have the option to register for certified Massive Open Online Courses (MOOCs) (NPTEL/SWAYAM) limited to 9 credits for their elective credit requirement. Credits earned through certified MOOCs will also be used for SGPA/CGPA computations (refer Clause No: 8.15).

A student must provide all the details (original or attested authentic copies) such as course content, number of contact hours, course instructor and evaluation system for the certified course which she/he requests to be considered in order to fulfil the designated credit requirement.

These details will be evaluated by the concerned DUGC before giving the approval. The DUGC will then decide the number of equivalent credits the student will get for such course(s) in the Institute. The complete details will then be forwarded to Dean (AP) for approval.

7.8 Internship/Major project

(a) The department/Industry Internship and/or Major Project work shall carry a total of 27 credits, distributed over the 6th, 7th and 8th semesters, with 9 credits in each semester (of duration 6 months each).

(b) Of the three Internship/Major Project slots offered during these semesters, a student may undertake a maximum of two semesters of Internship/Major Project outside the Institute in an industry/ academic institution/ R&D organization with the prior approval of DUGC.

(c) A student intending to undertake an Internship/Major Project in a foreign institution or organization shall obtain the prior approval of the Dean (AP) based on the recommendation of the DUGC.

(d) Students are encouraged to undertake an Internship/Major Project outside the Institute for a continuous period of at least six months. Where the duration is shorter, an Internship/Major Project of approximately two months or four months shall carry 3 credits or 6 credits, respectively, and shall be evaluated by the DUGC based on the prescribed completion certificate(s). The same duration and corresponding credit provisions shall apply to Major Projects undertaken within the Institute.

(e) Students undertaking Internships/Major Project outside the Institute shall ensure the successful completion of all other academic courses and credit requirements prescribed for the corresponding

semesters. The method of evaluation of all Internships/Major projects shall be evolved by pertinent DUGC and approved by the Dean (AP).

(f) The Institute shall not be liable for the payment of any scholarship, fellowship, stipend, financial assistance, or fees in respect of a student undertaking an Internship / Major Project outside the Institute.

7.9 Life-skill courses

Life-skill activities are integral part of the curriculum, for imparting physical (sports), cultural, technical and professional (communication) skills to the students. Faculty instructors/ coordinators will be assigned for planning, organizing and evaluating each of these activities.

7.10 Types of Life-Skills

Physical: These involve indoor and outdoor activities (to gain physical skills and health). They include activities such as, table tennis, archery, badminton, gymnastics, weight-lifting, juggling, chess, carroms, billiards, cricket, basketball, handball, volleyball, football, lawn tennis, swimming, hockey, kabaddi, Kho-Kho, javelin throw, Kung-Fu, Kalarippayattu, Yoga, NSS, trekking, rock climbing, rappelling and NADAL.

Cultural: These involve fine arts and performing arts (for creativity and mental health). They include activities such as, painting, poetry, photography, animation, film-making, calligraphy, pottery, sculpting, bamboo-craft, paper craft, gardening, food making, music (Hindustani, Carnatic, etc.), dancing, dramatics, language (local, national, international), IKS, fashion design, interior design, toy-making, folk art, debating, quizzing, radio jockey, story-telling and stand-up comedy.

Technical: These involve technical product fabrication (to hone technical skills). Examples include building prototypes (or parts of) airplane, glider, drone, submarine, racing car, self-driving vehicle, rocket, satellite, ham radio, astronomy, bionic device, robot, smart home, smart campus, cookware, sanitation, medical device, personal wearable, renewable energy device, plastic recycling, water saving and waste processing, etc.

Professional: These involve giving technical talks (for communication skills), at events organized by professional societies or local chapters such as ACM, ASCE, ACS, ASME, ASTM, IEEE, IE, IET, ISTE, SAE, SME, TEDx and Rotaract. Students can also participate in hackathons, business plan competitions and start-up pitching events organized by Entrepreneurship Cell, incubators and other organizations.

7.11 NCC for Holistic Life-Skills Development

As part of the Life-Skills activities, students may enrol in the National Cadet Corps (NCC), which provides opportunities for holistic development through the four Life Skills -Physical, Cultural, Technical and Professional. NCC also fosters discipline, leadership, teamwork, physical fitness, a spirit of service and responsible citizenship.

7.12 Life-Skill Levels

Each activity can be at three levels: 1- Basic, 2- Intermediate, and 3- Advanced, to be offered in the first, second and third year, respectively. Students will join the basic level and continue the same activity at higher levels in subsequent semesters to master the activity and participate in regional and national competitions.

Each student will spend at least 2 hours per week (1 credit) per activity and participate in all four types of activities (i.e., 4 credits per semester), from first to fifth semester (total 20 credits).

7.13 UG Students registering for PG courses as electives

Undergraduate students can register for a postgraduate course as elective, with prior approval of the Course Instructor, and the concerned Faculty Advisor and DUGC.

7.14 Opportunities for Additional Learning: Minor & Honors

The B.Tech. programme recognizes the diverse academic interests, abilities and career aspirations of students, as well as the evolving demands of higher education and industry. Accordingly, the curriculum provides academically eligible students with the flexibility to pursue additional learning opportunities beyond the prescribed degree requirements.

Students in good academic standing may register for additional courses, projects or other approved academic activities, subject to the prerequisites prescribed for such courses. These additional learning opportunities may be utilized to pursue interdisciplinary studies, advanced courses, research, innovation, entrepreneurship or other areas of academic interest. The credits earned under this provision shall be recorded separately in the grade cards and shall be appropriately reflected in the degree certificate.

7.15 Minor Programme in B.Tech.

Minor is an additional credential a student may earn if she/he does 15 credits worth of additional courses in a discipline other than her/his major discipline of B.Tech. degree.

(a) A student in a particular discipline can take additional specified courses approved by the respective DUGC totalling 15 credits for,

  (i) Minor in other disciplines where all the courses are offered by a department other than students' parent department.

  or

  (ii) Interdisciplinary Minor where courses are offered by two or more departments.

(b) Institute shall have the power to set the minimum number of students required for offering a Minor Programme and shall limit the number of seats for any Minor Programme.

(c) Institute cannot guarantee admission to any specific Minor Programme. Also, there shall be separate fees applicable for the Minor Programme, which will be decided by the Institute from time to time.

(d) Admission to a Minor Programme shall be based on the CGPA obtained at the end of the first year (first two semesters). Students with a minimum CGPA of 6.5 shall be eligible to apply for all Minor Programmes, except the Minor Programmes offered under NADAL, for which the minimum CGPA requirement shall be 6.0. The allotment of seats shall be made on the basis of a merit list prepared using the first-year CGPA, subject to the availability of seats.

(e) A student can opt for Minors after the Third Semester and register for minor courses from Fourth to Eighth Semesters.

(f) All courses registered as part of the minor programme in a semester are to be successfully completed in the same semester, including the makeup exam, and no re-registration is permissible.

(g) A student registering for a minor course shall pay the prescribed, non-refundable fee within the first week of the semester.

(h) A student registered for a Minor Programme may earn up to 3 credits towards the Minor credit requirement through a certified MOOC course offered on the NPTEL/SWAYAM platform, subject to the approval of the DUGC. The credits and grades earned shall be included in the computation of

the SGPA and CGPA. For the credits earned through the certified MOOC course in lieu of a Minor course, the student shall be exempted from paying the prescribed minor course fee for that course.

(i) If the student earns the specified total number of credits required for the minor discipline, then it will find a mention in the student's grade cards and degree certificate.

(j) If a student of a minor programme does not become eligible for the Minor degree, then the credits for completed Minor courses may be considered as elective courses for the regular B.Tech. degree. However, the fee paid for the minor courses will not be refunded.

(k) The degree certificate shall have the following pattern for those who complete the Minor programme - Bachelor of Technology in "Programme name of the parent department" with minor in "name of the minor programme".

7.16 Honors Programme in B.Tech.

Honors is an additional credential a student may earn if she/he opts for the extra 15 credits at the postgraduate level needed for this in her/his own discipline. The concerned department specifies the set of courses for earning Honors. Honors is not indicative of class.

(a) A student in a particular discipline can take additional courses specified by respective DUGC at postgraduate level in the same discipline totalling 15 credits. If the student gets a GPA of 6.0 and above in these courses, then it will find a mention in their grade cards and degree certificate.

(b) A student can opt for Honors after the end of Third Semester and register for Honors Courses from Fourth to Eighth Semesters. Students who have cleared all the courses of first to third semester in first attempt and have obtained a minimum CGPA of 7.5 at the end of Third semester are eligible to register for Honors courses.

(c) A student registered for an Honors Programme may earn up to 3 credits towards the Honors credit requirement through a certified MOOC course offered on the NPTEL/SWAYAM platform, subject to the approval of the DUGC. The credits and grades earned shall be included in the computation of the SGPA and CGPA.

(d) If a student who has registered for an Honors programme does not become eligible for the Honors degree, then the credits for completed Honors courses can be considered as elective courses for the regular B.Tech. degree.

(e) The degree certificate shall have the following pattern for those who complete the Honors Programme - Bachelor of Technology in "Programme name of the parent department" with honors in "Name of the appropriate PG programme specialization" (out of the 15 credits, a minimum of 12 credits should be from the same PG programme specialization. If the student does not fulfil this criterion, then she/he will be awarded the degree certificate without mentioning the honors specialization, i.e., Bachelor of Technology in "Programme name of the parent department" with honors).

8. Assessment and Evaluation Plan

8.1 Each course shall adopt appropriate assessment methods aligned with its learning outcomes and nature. The assessment may comprise one or more components, including class participation, assignments, quizzes, laboratory work, fieldwork or field-visit reports, seminars, presentations, group activities, term projects, mid-semester examinations and end-semester examinations.

8.2 The academic performance of a student shall be evaluated using a letter grading system based on the Class Performance Distribution comprising different components. The award of grades shall be based on the student's overall performance in a course. Grades shall be awarded through a fair, objective, transparent and consistent evaluation process designed to ensure reliability and academic integrity.

8.3 Academic performance in each course shall be indicated by a double-letter grade (AA, AB, BB, BC, CC, CD, DD and NC) on a 10-point grading scale, reflecting the student's level of academic achievement.

8.4 Letter-Grades and Grade-Points

Table 4: Letter grades and grade points

LETTER-GRADE	GRADE-POINTS	REMARKS
AA	10	
AB	9	
BB	8	
BC	7	
CC	6	
CD	5	
DD	4	
NC	0	Not Complete
SA	0	Shortage of Attendance
IE	-	Incomplete End-Sem Exam
U	-	Audited
W	-	Withdrawal

8.5 The double-letter grade awarded to a student in a course shall be based on the student's performance in continuous assessment components, such as quizzes, assignments, tutorials, seminars, term projects, attendance, and other academic activities, as applicable, together with the mid-semester and end-semester examinations. As a general guideline, it is recommended that the continuous evaluation, mid-semester and end-semester examinations will respectively carry 40%, 20% and 40% weightage. However, considering courses with different L-T-P structure, the weightage given to the three components may vary as given below:

End-Semester Examination : 35 to 50% (2 - 3 hours duration)
Mid-Semester Examination : 20 to 25% (1 – 1½ hours duration)
Quizzes, Tutorials, Assignments, Practicals, Projects,
Attendance, etc. (continuous evaluation) : 30 to 45% (to make up for 100%)

Any variation, other than the above distribution, requires the approval of the pertinent DUGC.

8.6 For any undergraduate course offered to more than one section/department, a common question paper, scheme of evaluation and grading shall be followed for both mid semester and end semester examinations. The respective DUGC may decide about the weightage to be given to each individual component, viz., tutorials, assignments, mid semester and end semester examination etc.

8.7 The Course Instructor shall, within the first week of the semester, communicate to the students and the respective DUGC the course plan, evaluation scheme, including the weightage of each assessment component, and the requirements for the award of a U grade for audited courses, by announcements in

the class and/or through the online portal IRIS or any other approved mode of communication.

8.8 A student intending to earn credits through approved MOOCs (e.g., NPTEL/SWAYAM) shall register for courses of at least 8 weeks duration for 3 credits or 12 weeks duration for 4 credits. Upon successful completion, the student shall submit the Course Completion Certificate and/or Grade Card to the respective DUGC. The student shall submit the course completion certificate and/or grade card prior to semester-end grade finalization meeting for the award of a letter grade, which shall be included in the computation of the SGPA and CGPA.

8.9 The DUGC shall verify the authenticity of the MOOC (NPTEL/SWAYAM) Course Completion Certificate using appropriate means, such as, scanning the QR code or using any other official certificate verification mechanism provided by the platform before recommending the award of credits and grades. The verification shall confirm the student's identity, course title, course duration, offering institution, faculty/instructor, final score or grade, and the validity of the certificate.

8.10 Grading of MOOC Courses

The following grading policy shall apply to all MOOC courses.

Score (%) obtained in the MOOC	Institute Equivalent Grade
≥ 90	AA
75 - 89	AB
60 - 74	BB
40 - 59	BC
< 40 (No Certificate)	Course will not appear in the grade card

8.11 Earned Credits

Earned Credits are the credits associated with a course for which a student has obtained any of the passing double-letter grades (AA, AB, BB, BC, CC, CD or DD). No credits can be earned for courses awarded NC or SA grades.

8.12 Cutoff Marks for Grades

The minimum cutoff marks for AA grade as well as the maximum cutoff marks for NC grade will be decided by the Course Instructor based on the specific relevant details of the Class Performance Distribution (using appropriate class performance statistics parameters, like the Class-Mean, Class-Standard-Deviation, etc.), with the approval from DUGC. As a general guideline, the minimum cut-off marks for the award of AA and DD grades shall normally be 70% and 20%, respectively. The minimum/maximum cutoff marks for the intermediate grades are determined by appropriate partitioning/clustering method based on the specific relevant details of the Class Performance Distribution. Any deviation from these guidelines shall require the approval of the respective DUGC, supported by appropriate justification from the Course Instructor.

8.13 Description of Grades

AA Grade

The AA grade denotes outstanding performance in a course. As a general guideline, the AA grade shall normally be awarded to not more than 10% of the students in a theory course and not more than 20%

of the students in a laboratory, project or internship course, based on their overall performance. All gradings shall require the approval of the respective DUGC.

DD Grade

The DD grade denotes the minimum passing performance in a course.

NC Grade

The NC (Not Complete) grade denotes non-completion of the course requirements due to unsatisfactory academic performance. The NC grade shall remain permanently recorded in the Grade Card.

SA Grade

The SA (Shortage of Attendance) grade denotes failure to satisfy the minimum attendance requirement prescribed by the Institute. A student awarded the SA grade shall re-register for the course when it is next offered. For an elective course, the student may either repeat the same elective or register for another approved elective. The SA grade shall remain permanently recorded in the Grade Card.

IE Grade

The IE (Incomplete End-semester Examination) grade may be awarded to a student who is unable to appear for the end-semester examination due to valid reasons (refer Clause No: 10.3). Upon completion of the pending evaluation, the IE grade shall be converted to the appropriate letter grade; a penalty of ONE Grade-Point is imposed by awarding the double-letter grade that is immediately below the one that the student would have otherwise received. However, the penalty clause shall not apply to a student earning a DD grade.

U Grade

The U (Audit) grade shall be awarded to a student who successfully completes the requirements of an audit course, including the minimum attendance and evaluation requirements prescribed by the Course Instructor and approved by the respective DUGC. Failure to satisfy these requirements shall result in the course not being reflected in the Grade Card.

W Grade

The W (Withdrawal) grade shall be awarded to a student who is permitted to withdraw from a course with the approval of the Dean (AP) on the recommendation of the respective DUGC. Withdrawal shall not be permitted after the finalization of semester grades. The W grade shall remain permanently recorded in the Grade Card.

8.14 Makeup Examination

A student who earns NC grade for a theory or a lab course in a semester may be permitted to appear for a makeup end-semester examination which will be conducted immediately after the declaration of the results of the semester. A student who passes the makeup examination shall be awarded a maximum grade of DD.

In case, a student gets NC grade again in the makeup examination, the course has to be repeated when it is offered next time, and the student will be eligible for relaxation in the attendance, but has to appear for all the in-semester and end-semester assessment components. However, in the case of elective courses, alternative elective courses can also be chosen. The NC grade shall remain permanently recorded in the Grade Card.

8.15 Evaluation of Performance

The overall performance of a student will be indicated by two indices: SGPA which is the Semester Grade Point Average and CGPA which is the Cumulative Grade Point Average.

(a) Semester Grade Point Average (SGPA): The SGPA for a semester is calculated as the weighted average of the grade points earned in all courses taken during that semester.

$$\text{SGPA} = \frac{[\sum (\text{Course credits}) \times (\text{Grade Point})] \text{ for all courses with double-letter grades, including NC and SA (in that semester).}}{[\sum (\text{Course credits})] \text{ for all courses with double-letter grades, including NC and SA (in that semester).}}$$

(b) Cumulative Grade Point Average (CGPA): The CGPA is the weighted average of grade points earned in all courses successfully completed from the first semester up to the current semester.

$$\text{CGPA} = \frac{[\sum (\text{Course credits}) \times (\text{Grade Point})] \text{ for all courses with double-letter grades, including all NC and SA grades.}}{[\sum (\text{Course credits}) *] \text{ for all courses with double-letter grades, including all NC and SA grades.}}$$

* Whenever a student reappears for a course in which she/he has been awarded NC or SA grade, the CGPA computations will not once again include the course credits for the failed courses in the denominator.
* There is no equivalence between the CGPA Scale and Percentage. However, CGPA ≥ 6.0 can be considered as equivalent to first class and 5.0 ≤ CGPA < 6.0 can be considered as equivalent to Second Class. Notionally, CGPA may be multiplied by a factor of 10 to obtain numerical percentage.

8.16 Report of Marks, Declaration of Grades and Class Performance Statistics

(a) Students shall be permitted to inspect their evaluated answer scripts and marks pertaining to various assessment components (such as quiz/test papers, mid-semester/ end-semester papers etc.), except those related to internships and project work, within the time stipulated by the course instructor.

(b) The process of evaluation shall be transparent, and the students shall be made aware of all the factors included in the evaluation. In case of any correction, the course instructor shall have to incorporate the same before finalization of the grades. The Course Instructor shall upload the marks of all evaluation components to IRIS portal before submitting the final marks and grades to the respective DUGC.

(c) The Course Instructor shall submit the Report of Marks and Grades for each student, along with the Summary Report of Marks and Grades containing the class performance statistics, in the prescribed format to the Chairperson, DUGC, by the stipulated date. The Secretary, DUGC, in consultation with the Chairperson, shall convene the DUGC meeting within the timeline specified in the Academic Calendar for moderation, if required, and final approval of the marks and grades.

(d) All students will be able to see the marks and the grades as soon as the chairperson of concerned DUGC approves the grades on IRIS portal. The marks and grades can also be seen by the concerned

parent/guardian through the appropriate interface available in IRIS portal. A student seeking clarification regarding the grade awarded in a course shall approach the concerned Course Instructor within ONE working day of the display of the grades.

(e) The DUGC shall submit the final approved Report of Marks & Grades along with Summary Report of Marks & Grades containing the class performance statistics, in the prescribed format, to the office of the Dean (AP) within the stipulated date.

(f) The Student Progress Report shall contain the Letter-Grade for each course; along with the SGPA, and the CGPA.

(g) At the end of each semester, every student shall ensure that the credits earned during the semester are duly updated in the Academic Bank of Credits (ABC) through the designated online portal.

8.17 Appeal for review of Grades

(a) A student seeking clarification regarding the evaluation or the grade awarded shall first approach the Course Instructor. If the grievance is not resolved satisfactorily, the student may submit a representation to the respective DUGC.

(b) A student aggrieved by the decision of the DUGC may appeal to the Departmental Academic Appeals Board (DAAB) for review of the grade, in the prescribed format, on or before the date specified in the Academic Calendar. The decision of the DAAB shall be final and binding.

8.18 Policy on Retention of Answer Scripts

All mid-semester and end-semester answer scripts shall be retained by the respective course instructor(s) or the concerned academic unit for a minimum period of three academic years from the date of declaration of the results to facilitate student grievance redressal, academic audit, and programme accreditation requirements. Upon completion of the prescribed retention period, the answer scripts may be permanently disposed of in accordance with the Institute's record retention and disposal procedures.

8.19 Course Feedback Requirement

Students shall submit online course feedback for every registered course at the end of each semester. The feedback shall cover various aspects of the course, including the curriculum, course delivery, teaching effectiveness, assessment methods and overall learning experience.

8.20 Grade Cards

At the end of each semester, every student shall receive a grade card containing:

- Course number, name, and credits for all registered courses.
- Letter grade earned in each course.
- Total credits accumulated by the student up to the end of the semester, categorized by course type.
- Academic performance indicators, including the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA).

9. Attendance Requirements

9.1 Every student is expected to maintain 100% attendance in all academic activities.

9.2 The Course Instructor shall update the attendance records of students in the Institute online portal IRIS after each class or at least once every week, enabling students to monitor their attendance status. The

attendance shall be finalized at least three calendar days before the last day of classes to determine the eligibility of students to appear for the End-Semester Examination. The finalized attendance shall be notified to the students through IRIS portal or any other approved mode of communication, with a copy submitted to the Head of the Department.

9.3 Students must have a minimum of 75% attendance in each course to be eligible to appear for the End-Semester Examination. The permissible absence of up to 25% shall include absence on account of medical reasons and/or approved Institute activities.

9.4 Relaxation in Attendance

The Dean (AP) may grant a further relaxation of up to 10% in the minimum attendance requirement with the advice from the Dean (SW) and on the recommendation of the Head of the Department, for students representing the Institute in approved academic, co-curricular, extracurricular or sports activities. Similarly, the Dean (AP) may grant a further relaxation of up to 10% in the minimum attendance requirement on serious medical grounds, based on the recommendation of the Head of the Department and subject to verification and approval of the supporting medical documents by the Institute Medical Officer.

9.5 A student who fails to satisfy the minimum attendance requirement of 75% in a course, considering lectures, tutorials and practical sessions together, as applicable, shall not be permitted to appear for the End-Semester Examination in that course and shall be awarded an SA grade, irrespective of the student's academic performance or the reasons for the shortage of attendance.

9.6 A student re-registering for the same course after obtaining an NC grade may be exempted from the minimum attendance requirement, subject to the prior approval of the Heads of both the parent department and the department offering the course, on the recommendation of the Faculty Advisor. This exemption shall not be applicable to students awarded an SA grade or to those registering for an alternative elective in place of a failed elective course.

10. Absence during the Semester

10.1 Leave of Absence

(a) A student requiring leave of more than two days and up to two weeks shall submit a prior application to the Head of the Department, through the Faculty Advisor, stating the reasons for the leave and enclosing the necessary supporting documents.

(b) If the period of leave is two weeks or more, prior application for leave shall have to be made to the Dean (AP) with the recommendations of the Faculty Advisor and the concerned HOD stating fully the reasons for the leave requested, along with supporting documents. The Dean (AP) may, on receipt of such application, grant leave or also decide whether the student be asked to withdraw from the course for that particular semester because of long absence.

(c) It will be the responsibility of the student to intimate the Course Instructors, and also the Dean (SW) as well as the Chief Warden of the hostel, regarding her/his absence before availing leave.

10.2 Absence during Mid-Semester Examination

A student who has been absent from a Mid Semester Examination due to illness and other contingencies may give a request for make-up examination within two weeks after the Mid Semester Examination to the HOD with necessary supporting documents and certifications from authorized

personnel. The HOD may consider such requests depending on the merits of the case, and after consultation with the course instructor, may permit the makeup Mid Semester Examination for the concerned student.

10.3 Absence during End-Semester Examination

In case of absence for an End Semester Examination, on medical grounds or other special circumstances, the student can apply for IE grade in that course with necessary supporting documents and certifications by authorized personnel to the HOD. The HOD may consider the request, depending on the merit of the case, and after consultation with the Course Instructor, permit the makeup End Semester Examination for the concerned student (possibly arranged along with those students who were awarded the NC grade, refer Clause No: 8.14 on Makeup Exam). The student may subsequently complete all course requirements within the period announced in Academic Calendar (which may possibly be extended till first week of next semester under special circumstances) and IE grade will then be converted to an appropriate Double-letter grade, as per Clause No: 8.13 (Description of Grades: IE Grade, above). All the particulars of such a decision with date of finalizing the grade shall be communicated to Dean (AP). If such an application for the IE grade is not made by the student, then a double-letter grade will be awarded based on her/his in-semester performance.

11. Transfer of Credits

11.1 The courses credited elsewhere, in reputed Indian or foreign University / Institutions / Colleges by students during their study period at the Institute may count towards the credit requirements for the award of degree. The credits transferred will reduce the number of courses to be registered by the student at the Institute. The guidelines governing the transfer of credits are as follows:

(a) Undergraduate students with consistent academic performance and CGPA ≥ 7.5 can credit courses approved by the concerned DUGC of the programme in other Institutions during 3rd and 4th year and during summer breaks.

(b) Students can earn external credits only from IISc/IITs/NITs/IIMs and other reputed Indian or foreign Universities/Institutes/Colleges with which the Institute has an MOU.

(c) The appropriate credit mapping in the above cases will be done by Dean (AP).

(d) A student seeking transfer of credits shall submit the prescribed application together with the course syllabus, contact hours, evaluation scheme, details of the Course Instructor/Project Guide, the approval or acceptance letter from the host institution, and other relevant supporting documents. The respective DUGC shall assess the equivalence of the course(s), recommend the admissible credits for transfer, and forward its recommendation to the Dean (AP) for approval.

(e) The maximum number of credits that can be transferred by a student shall be limited to 20.

12. Withdrawal from the Programme

12.1 Temporary Withdrawal

(a) A student may be permitted to withdraw temporarily from the programme for one or more semesters on grounds such as prolonged illness, grave family exigencies, or other exceptional circumstances, subject to the following conditions:

(i) The student submits an application, along with supporting documents and the consent of the

parent/guardian, stating the reasons for the withdrawal.

(ii) The Institute is satisfied that the student can complete all the degree requirements within the maximum permissible duration of the programme, including the period of approved withdrawal.

(iii) The student has cleared all outstanding dues payable to the Institute, including those relating to the Department, Hostel, Library and any other Institute facilities.

(iv) Scholarship/Fellowship holders are bound by the appropriate rules applicable to them.

(v) The withdrawal is approved by the Director of the Institute, whose decision shall be final.

(b) A student shall normally be permitted only one temporary withdrawal during the tenure of the programme. The approved period of withdrawal shall be counted towards the maximum duration prescribed for completion of the programme.

12.2 Permanent Withdrawal

Any student who withdraws admission before the closing date of admission for the Academic Session is eligible for the refund of all the fees and deposits, after a deduction of a processing fee.

Once the admission for the year is closed, the following conditions govern withdrawal of admissions:

(a) A student seeking permanent withdrawal after the closure of admissions shall be permitted to do so (and take Transfer Certificate from the Institute, if needed), only after clearing all outstanding dues payable to the Institute, including those relating to the Department, Hostel, Library and any other Institute facilities. Also, all the fees and charges already paid will not be refunded on any account.

(b) A student who has received any scholarship, stipend, fellowship or other forms of assistance from the Institute shall repay all such amounts in addition to those mentioned in Clause No. 12.2(a) above.

(c) The decision of the Director of the Institute regarding all aspects of withdrawal of a student shall be final and binding.

13. Degree Requirements

The degree requirements of a student for the B.Tech. programme are as follows:

(a) **Institute Requirements**: Minimum Earned Credit Requirement for the Degree is 150-152

(b) **Programme Requirements:** Minimum Earned Credit Requirements on all Core Courses, Elective Courses and Internships/Major Projects as specified by the DUGC and conforming to Course Structure (Clause No: 7).

(c) The Maximum duration for a student for complying to the Degree Requirement is EIGHT years, including the temporary withdrawal period and/or the intervening period between the multi-exit/entry scheme, if applicable, from the date of first registration for her/his first semester.

14. Termination from the Programme

A student shall be required to leave the Institute without the award of the Degree, under the following circumstances:

(a) If a student fails to earn the minimum credit specified below:

Check Point	Credit Threshold
End of FIRST year	15
End of SECOND year	40
End of THIRD year	60
End of FOURTH year	80

***Note**: The period of temporary withdrawal is not to be counted for the above Credit Threshold.*

(b) If a student is absent for more than 6 (Six) weeks at a stretch in a semester without sanctioned leave.

(c) Based on disciplinary action suggested by the Senate, on the recommendation of the appropriate committee.

Note: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer to Clause No: 12.2) shall also apply.

15. Conduct and Discipline

15.1 Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of an Institution of National Importance.

15.2 As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

15.3 The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures:

(a) Ragging: Ragging is any act of verbal, physical or mental abuse, humiliation or harassment of a student by senior students, often under the pretext of welcoming them. It includes bullying, criminal intimidation, assaulting, forcing to perform embarrassing tasks, unnatural offenses, use of force, wrongful restraint, exclusion and financial extortion, etc.

(b) Harmful materials: Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.

(c) Sexual harassment: Violation of dignity or unwelcome/offensive behavior including physical contact, sexual remarks, showing pornography, demanding sexual favors and any other verbal or non-verbal conduct of sexual nature inside the campus or online.

(d) Caste-based discrimination: Unfair treatment of a person based on caste, race or religion including verbal abuse, derogatory comments, social exclusion, biased treatment, harassment, denial of rights or opportunities, bullying, targeted attack and violence

(e) Malpractice in academic activities, including examinations, assignments, projects, laboratory work etc.

(f) Public display of affection: Inappropriate, insensitive and disrespectful behavior, affecting the decorum and professional environment.

(g) Lack of courtesy and decorum; indecent behaviour.

(h) Wilful damage or stealthy removal of any property/belongings of the Institute/Hostel or of fellow students/citizens.

(i) Mutilation or unauthorized possession of library books.

(j) Noisy and unseemly behaviour, disturbing studies of fellow students.

(k) Hacking in computer systems (such as entering into other person's area without prior permission,

manipulation and /or damage of computer hardware and software or any other cyber-crime etc.)

(l) Plagiarism of any nature.

(m) Any other act of gross indiscipline as decided by the Senate from time to time.

Commensurate with the gravity of offense, the punishment may be: reprimand, fine, expulsion from the hostel, debarring from an examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

15.4 For an offence committed in (i) a hostel (ii) a department or in a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department and the Dean (SW), respectively, shall have the authority to reprimand or impose fine.

15.5 Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Dean (AP) for taking appropriate action.

15.6 All cases of serious offence, possibly requiring punishment other than reprimand, shall be reported to the Director.

15.7 The Institute Level Disciplinary Committee constituted by the Director, shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.

16. Residence

16.1 The institute is wholly residential and all full-time students shall be required to reside in the hostels.

16.2 Under special circumstances, the Dean (SW) may permit a student to reside with her/his parent/guardian in the Institute campus or within a reasonable distance from the Institute.

16.3 Every resident student shall comply with the Hostel Rules and Regulations and all directions issued by the Board of Hostel Management and the Institute from time to time.

17. Graduation Requirements and Convocation

17.1 A student shall be eligible for the award of the degree if she/he has:

(a) Fulfilled all the prescribed Degree Requirements

(b) No dues to the Institute, Departments, Hostels, Library, and any other centres

(c) No disciplinary action pending against her/him.

17.2 The award of the degree shall be recommended by the respective DUGC to the Senate for approval and, thereafter, to the Board of Governors (BoG) for the conferment of the degree.

17.3 Convocation

Degrees shall be conferred at the Annual Convocation on students who have successfully fulfilled all the prescribed degree requirements during the preceding academic year. Students who are unable to attend the Convocation may be awarded the degree in *absentia*. Eligible students shall submit the prescribed application, together with the applicable fee, within the notified schedule.

18. Committees / Functionaries

The following committees shall be constituted for the various degree programmes offered by the Institute including the undergraduate (B.Tech.) degree programme:

18.1 Board of Studies (BoS)

Constitution:

(a)	Dean (AP)	:	Chairperson
(b)	All other Deans	:	Members
(c)	Associate Dean(s) of Academic Programs	:	Member(s)
(d)	Associate Dean(s) of Students Welfare	:	Member(s)
(e)	HoDs / Chairperson of DUGC(s) or her/his nominee	:	Member
(f)	Librarian	:	Member
(g)	BoG members representing the faculty	:	Members
(h)	External Expert(s)	:	Members
(i)	Assistant Registrar (Academic)	:	Convener
(j)	Deputy/Asst. Registrar (Academic)	:	Secretary

Note:

- There shall be one BoS for the entire Institute.
- The Chairperson may co-opt and/or invite more members.
- The quorum of each meeting shall be 50%.

Function Highlights

(i) To consider the recommendations of the DUGC on matters relating to undergraduate programme and to make suitable recommendations to the Senate.

(ii) To approve curriculum framed / revised by DUGC for the undergraduate courses of study.

(iii) To ensure that all norms and Regulations pertaining to undergraduate programme are strictly followed.

(iv) To make periodic review of these Regulations pertaining to undergraduate programme and to recommend to the Senate any modifications thereof.

(v) To conduct at least one meeting each semester and send the Resolutions to the Chairperson of the Senate, and also to maintain a record of the same in the Academic Section of the Dean (AP).

(vi) Any appropriate responsibility or function assigned by the Senate or the Chairperson of the Senate.

18.2 Departmental Undergraduate Committee (DUGC)

Constitution:

(a)	HOD / Programme Coordinator	:	Chairperson
(b)	Two Professors (by rotation for two years)	:	Members
(c)	Two Assoc. Professors (by rotation for two years)	:	Members
(d)	Two Asst. Professors (by rotation for two years)	:	Members
(e)	A Faculty member (by rotation for two years)	:	Secretary

Note:

- There shall be one DUGC for every department that is involved in the teaching for the B.Tech. Degree programme.
- The Secretary (DUGC) shall be nominated by the Chairperson on rotation basis for a period of two years.
- The Chairperson may co-opt and/or invite more members including at most three outside

experts.

- The quorum for each meeting shall be five.

Function Highlights

(i) Examine issues arising from revisions to the Academic Regulations and Curriculum and recommend appropriate measures to the Board of Studies (BoS)/Senate to ensure a fair and smooth transition for students admitted under earlier regulations, including matters relating to curriculum mapping, credit requirements, and other academic requirements. The approved recommendations shall be implemented accordingly.

(ii) To monitor the conduct of all undergraduate courses of the department.

(iii) To ensure academic standard and excellence of the courses offered by the department.

(iv) To oversee the evaluation of each of the students in a class, for each of the courses.

(v) To develop/revise the curriculum for undergraduate courses offered by the department, and recommend the same to the BoS.

(vi) Moderation (only if and when found necessary) in consultation with the Course Instructor, and approval of the finalized grades, before submission of the same to the Academic Section of the Dean (AP).

(vii) To consolidate the registration of the students and communicate to Course Instructors, and also to the Academic Section of the Dean (AP).

(viii) To consider any matter related to the undergraduate programme of the department.

(ix) In cases where a course is taught by more than one faculty member, or by different faculty members for different sections of students, DUGC shall co-ordinate (only in case of need) among all such faculty members regarding the teaching and evaluation of such courses.

(x) To conduct at least two meetings each semester and send the Resolutions of the meeting to the Academic Section of the Dean (AP), and also to maintain a record of the same in the department.

(xi) Perform such other functions and responsibilities as may be assigned by the Senate, the Chairperson of the Senate, the Board of Studies (BoS), or the Chairperson of the BoS.

18.3 Departmental Academic Appeals Board (DAAB)

Constitution:

(a)	HOD of the Parent Department	:	Chairperson
(b)	Three faculty members of the parent Department (1 Prof. + 1 Assoc. Prof. + 1 Asst. Prof.)	:	Members
(c)	One Professor from outside the Department nominated by Dean (AP)	:	Member
(d)	Faculty Advisor(s) of the Class from where the Appeal originates	:	Member(s)

Note:

- There shall be one DAAB for every department.
- The Chairperson may co-opt and/or invite more members.
- Depending on the prevailing circumstances, a Senior Professor of the Department, nominated by the Dean (AP), shall act as Chairperson instead of Head of the Department.
- If the concerned instructor is a member of DAAB then she/he shall keep herself/himself out of the Board during deliberations.

Function Highlights

(i) To receive grievances/ complaints in writing from the students regarding anomalies in award of grades due to bias, victimization, erratic evaluation, etc. and redress the complaints.

(ii) To interact with the concerned course instructor and the student separately before taking the decision.

(iii) The decision of the DAAB will be based on simple majority.

(iv) The recommendations of the DAAB shall be communicated to the Dean (AP) for further appropriate action as required.

18.4 Class committee

Every Class (group of students registered for a course) of the Degree Programme shall have a Class committee, consisting of Faculty and Students.

Constitution

(a)	HOD (or her/his nominee) of the Parent Department not associated with the class	:	Chairperson
(b)	Faculty Advisor(s) of the Class	:	Member-Secretary
(c)	Course Instructor(s)	:	Member
(d)	FOUR to SIX students from the Class/Course to be chosen by the students amongst themselves	:	Members

Function Highlights

(i) The basic responsibilities of the Class committees are to review periodically the progress of the classes, to discuss problems concerning curriculum and syllabi and the conduct of the classes.

(ii) Each Class committee will communicate its recommendations to the HOD/DUGC of the Parent Department.

(iii) There shall be minimum one class committee meeting at the middle of every semester as indicated in the academic calendar. However additional class committee meetings may be convened as decided by DUGC/Course Instructor.

(iv) The minutes of each Class committee meeting shall be recorded in a separate minutes register maintained in the Parent Department.

18.5 Faculty Advisor(s)

The Faculty Advisor(s) will be appointed by the HOD of the parent department, who will be assigned a specific group (admission-batch) of students of the concerned parent department and will be valid throughout their duration of study.

Function Highlights

(i) To help the students in planning their courses and related activities during their study period.

(ii) To monitor, guide, advice and counsel the students on all academic matters.

(iii) To coordinate the activities regarding mandatory learning courses.

18.6 Course Instructor

Function Highlights

(i) She/he shall conduct classes as prescribed in the Academic Calendar and as per the teaching assignment time table issued by the HOD.

(ii) She/he shall follow all the Regulations related to teaching of a course and evaluation of students.

(iii) She/he shall be responsible for all the records (i.e., course registration, answer books, attendance, etc.) of the students registered for the course.

(iv) She/he will arrange to distribute a course plan and the evaluation plan together with the course objectives, background materials to all the students within the first week of each semester.

(v) She/he will prepare an evaluation plan showing details of how the student's performance will be evaluated in the course.

(vi) She/he will properly document the students' performance and announce to the students as stipulated in the Regulations.

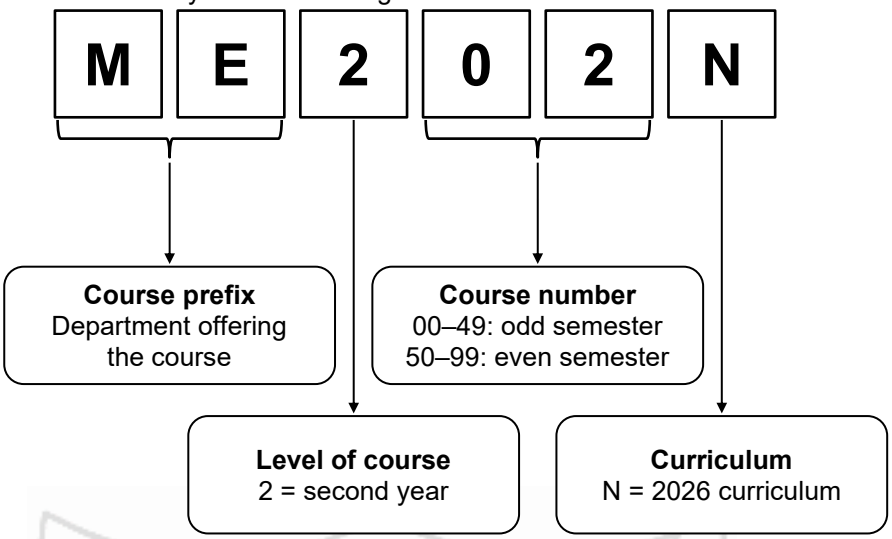
(vii) She/he will report to the HOD on a periodic (monthly) basis, the potential cases of very poor academic performance as well as those of low attendance, that would possibly result in a NC or SA grade at the end of the semester.

19. Power to Modify

Notwithstanding any provisions stated previously or elsewhere, the Senate of the Institute reserves the right to modify or amend, without prior notice, the curricula, procedures, requirements, and regulations governing its B.Tech. programmes whenever deemed necessary.

Course Code Naming Convention

Course Numbers are denoted by character strings.



Sl. No	Name of Academic Unit with Code (alphabetical order)	Course Prefix
1	Chemical Engineering, Department of (CH)	CH
2	Chemistry, Department of (CY)	CY
3	Civil Engineering, Department of (CE)	CE
4	Computer Science and Engineering, Department of (CS)	CS
5	Design and Entrepreneurship, Department of (DE)	DE
6	Electrical and Electronics Engineering, Department of (EE)	EE
7	Electronics and Communication Engineering, Department of (EC)	EC
8	Information Technology, Department of (IT)	IT (for B.Tech IT courses) AI (for B.Tech AI courses)
9	Inter-disciplinary Studies, Centre for (IS)	IS
10	Humanities, Social Sciences and Management, School of (SM)	SM
11	Mathematical and Computational Sciences, Department of (MA)	MA
12	Mechanical Engineering, Department of (ME)	ME
13	Metallurgical and Materials Engineering, Department of (MT)	MT
14	Mining Engineering, Department of (MN)	MN
15	Physical Education and Life-Skills, Department of (PL)	PL
16	Physics, Department of (PH)	PH
17	Water Resources and Ocean Engineering, Department of (WO)	WO

FIRST YEAR BACHELOR OF TECHNOLOGY

COURSE CONTENTS COMMON TO ALL UNDERGRADUATE PROGRAMMES

CS100N COMPUTER PROGRAMMING (C) (0-0-6) 3

Types of programming languages, Features of C, Structure of a C program, executing a C program, Characteristics, and applications. Constants, Variables, identifiers, keywords and Data types, Storage classes. Unformatted and formatted Input Output functions. Arithmetic, Relational, Logical, assignment, conditional, increment or decrement, bitwise, special operators, associativity, and precedence of operators. Different forms of if statements, switch case, continue, goto, break. Algorithms and flow chart. Loops: for, while, do-while, nested loop, jumps in loops. Single and Multi-dimensional array. String handling functions and operations. Functions, arrays within functions, nesting of functions, recursion, and parameter passing methods. Pointers introduction, operations. Dynamic Memory Allocation. malloc() and free(). Structures and unions introduction, structure and array, structure and function, nesting of structures, bitfields and unions. File operations and file opening modes.

Brian Kernighan and Dennis Ritchie, "The C Programming Language", Prentice Hall; 2nd edition, 2015
Byron S Gottfried, "Programming with C", Schaum's Outline Series, Tata McGraw-Hill, 4th Edition, 2018
R.G.Dromey, "How to solve it by computer", Pearson Education India; 1st edition, 2006
E Balagurusamy," Programming in ANSI C", 9th Edition, McGraw Hill, 2024
Herbert Schildt, C: The Complete Reference, McGraw Hill, 4th edition, 2017
Introduction To Programming In C, https://nptel.ac.in/courses/106104128
Problem Solving Through Programming In C, https://onlinecourses.nptel.ac.in/noc22_cs45/preview
Freecodecamp, https://www.youtube.com/watch?v=KJgsSFOSQv0
A Tutorial on Pointers and Arrays in C, https://github.com/jflaherty/ptrtut13

CS101N COMPUTER PROGRAMMING (PYTHON) (0-0-6) 3

Introduction to the Python programming language and execution environment. Python Fundamentals. Data and Variables. Variables, Operators, Expressions, Statements using built-in functions. Strings, Numbers. Conditional statements. Loops, range, break, continue. Lists - indexing, slicing, accessing elements, adding, removing, ordering, built-in operations. Tuples - Packing, unpacking, built-in operations and examples. Sets, Dictionaries - built-in operations and examples. Functions and Modules. Recursion. Classes, Objects, Methods - defining, attributes and operations, __init__. Inheritance, __super__ (). Exceptions and Exception Handling, File handling. Modules in Python. NumPy, SciPy, Plotting libraries. Examples.

Eric Matthes, "Python Crash Course", 2e. 2019. No Starch Press.
Allen B. Downey, "Think Python", 3e. O'Reilly, https://allendowney.github.io/ThinkPython/. 2024.
Dromey, R. G. (1982). "How to Solve it by Computer", Prentice-Hall International. ISBN 978-0-13-434001-2.
Paul Barry, "Head First Python", 3rd Edition, O'Reilly. 2023.
Al Sweigart, "Automate the Boring Stuff with Python", 3e. https://automatetheboringstuff.com/.
Kenneth A. Lambert, "Fundamentals of Python: First Programs", Cengage 2019.
Codecademy, https://www.codecademy.com/learn/learn-python-3
Freecode camp, https://www.youtube.com/watch?v=rfscVS0vtbw
Learn Python, https://inventwithpython.com/.
Python for Beginners, https://www.pythonforbeginners.com/
Awesome Python, https://github.com/vinta/awesome-python.
Python Spot, https://pythonspot.com/.
Google's Python Class, https://developers.google.com/edu/python

DE100N DESIGN THINKING AND PROTOTYPING (2-0-2) 3

Introduction, need and definition of Design Thinking, framework for design thinking; Empathize, need identification; Define, specification; Ideate, concept generation; Concept Selection; Product Architecture and detailed design; Packaging Design and Product Presentation; Final Prototype Demonstration and Design Expo.

Cross, N. (2023). Design thinking: Understanding how designers think and work (2nd ed.). Bloomsbury Visual Arts.
Singh, H., & Abdul Wahid, K. A. (2023). Design thinking: A user-centred approach to innovation. Marc & Zed Publishing.
Meinel, C., & Leifer, L. (Eds.). (2023). Design thinking research: Innovation – Insight – Then and Now. Springer.
Tiwari, S. R., & Swarup, R. R. (2024). Design thinking: A comprehensive textbook. Wiley India.

CY100N ENGINEERING CHEMISTRY (3-0-2) 4

Introduction to spectroscopy. UV-Vis spectroscopy. Beer-Lambert law. Chromophore and auxochrome. Fluorescence and phosphorescence. FTIR spectroscopy. Modes of vibration. Characteristic vibrational frequencies. Atomic absorption spectroscopy. Microscopic techniques. Electrochemistry. Secondary electrodes (calomel and glass). Polarization and overvoltage. Lead-storage battery. Fuel cell. Electroplating of metals (e.g., Cu) and its applications. Multilayer coating. Electroless plating and its use in printed circuit board. Electrochemical corrosion. Corrosion rate and factors affecting corrosion. Types of corrosion. Nanomaterials. Preparation of nanomaterials and properties of ZnO and TiO2 nanostructures. Properties and applications of nanocarbon. Green chemistry. Principles of green chemistry and green metrics (Atom economy and E-factor). Classification of polymers based on mechanism, thermal properties, and tacticity. Copolymerization. Addition, condensation and coordination polymerization. Molecular weights of polymer. Methods of polymerization. Glass transition temperature. Conducting polymers. Quantitative chemical analysis by volumetric titrations. Instrumental analyses for quantitative analysis. Green synthesis of organic compound.

Engineering Chemistry, R V Gadag, and A N Shetty, VAPS Knowledge Publishing, 2024
B. R. Puri, L. R. Sharma and Madan S Pathania, Principles of Physical Chemistry, Vishal Publishers, 49th Ed. 2020.
P. C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing, Delhi, 17th Ed. 2015.
Dr. E. R. Nagarajan, Wiley's Engineering Chemistry, 2nd edition, 2018.
C.N.R. Rao, Understanding Chemistry, Universities Press, 1999
Gowariker et al., Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, 1999
Engineering Chemistry Lab Manual supplied from Dept. of Chemistry, NITK, Surathkal.
Vogel's Text Book of Quantitative Chemical Analysis, Furnis et al. (ed) Pearson publication.

MA100N NUMERICAL METHODS (3-0-0) 3

Errors and Approximations. Solution of Algebraic, Transcendental and Polynomial equations - Bisection, fixed-point iteration methods. Newton-Raphson and Regula-falsi method. Linear system of equations – Gauss elimination, Jacobi, Gauss-Siedel, SOR. Power method for eigenvalues and Newton's method to the nonlinear system of equations. Newton's Forward difference and Backward difference Interpolation Methods. Newton's divided difference and Lagrange Interpolation Methods. Curve fitting using the principle of least squares. Numerical Differentiation - Polynomial Interpolation, Deduction of first and second order formulae. Newton-Cotes formula, Trapezoidal and Simpson's 1/3rd and 3/8th rules. Numerical solution of first order initial value problems: Euler's and Taylor-Series methods. Runge-Kutta methods. Predictor-Corrector methods.

Burden, R. L., and Faires, J.D., Numerical Analysis: Theory and Applications, India Edition, Cengage, 2012
Jain, R. K., Iyengar, S. R. K., and Jain, M. K., Numerical Methods: For Scientific and Engineering Computation, New Age international Publication, 2012

Kincaid, D. R., and Cheney, E. W. Numerical analysis: mathematics of scientific computing (Vol. 2). American Mathematical Society, 2009.
Gerald, C.F, and Wheatley, P. O., Applied Numerical Analysis, Pearson, 7th edition, 2007

MA101N ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS (3-0-0) 3

First-order ODEs- Separable, homogeneous, exact, linear, Bernoulli equations. Integrating factor method, modelling, linear ODEs. Initial value problems- Picard's iteration, conditions for existence and uniqueness of solution to an IVP. Higher order linear ODEs with constant coefficients: Homogeneous linear ODEs and Complementary function. Non-homogeneous linear ODEs and Particular integral, Euler-Cauchy equation. Second order linear ODEs with variable coefficients, Existence and uniqueness - Wronskian. Solving second-order linear ODEs with variable coefficients - Method of variation of parameter and Method of reduction of order. Introduction to PDE, their formation, and classification. Solution of PDEs by Lagrange and Charpit methods. Classification of second-order Linear equations. Fourier series. Solving Heat, Wave, and Laplace equations by the Method of Separation of Variables

E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley & Sons, 2010.
T. Myint-U, L. Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th Ed. Birkhäuser, 2009.
G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw-Hill, 1991.
Zachmanoglou, Thoe, Introduction to Partial Differential Equations, Dover Publications, 2012.
R.V. Churchill, J.W. Brown, Fourier Series and Boundary Value Problems, McGraw-Hill Education, 2006.

MA102N SERIES AND ORDINARY DIFFERENTIAL EQUATIONS (3-0-0) 3

Sequences of real numbers and their convergence criteria. Sandwich theorem, continuous function theorem for sequences, monotonic sequence theorem. Infinite series, geometric series, tests for series convergence, n-th term test, Integral Test. Comparison Tests, alternating series, absolute and conditional convergence. Ratio and Root Tests, Rearrangement theorem, Power series. Taylor series and Maclaurin Series, convergence of Taylor Series, first order ODE - various methods. Initial value problems - Picard's iteration, Conditions for existence and uniqueness of solution to an IVP. Second and higher order linear ODEs with constant coefficients - general solution for homogeneous equations (characteristic equations), Superposition principle. Euler-Cauchy equation, Particular integrals, Second order linear ODEs with variable coefficients. Existence and uniqueness -Wronskian, Method of variation of parameters. Method of reduction of order. Power Series Method and Series solutions of ODE.

G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas Calculus, Pearson Education, 2009.
E. Kreyszig, Advanced Engineering Mathematics, 11th Ed., John Wiley & Sons, 2010
G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw- Hill, 1991.
E.A. Coddington, An Introduction to Ordinary Differential Equations, PHI Learning 1999.

MA103N LINEAR ALGEBRA (3-0-0) 3

Solving linear systems using row operations, echelon forms, and understanding matrix rank for solution classification.

Compute LU-factorization, evaluate determinants, and find matrix inverses using elimination. Introduce vector spaces with examples, axioms, standard spaces, and basic structural properties. Study subspaces, test linear independence, construct bases, and determine dimensions for various vector spaces. Explore span, fundamental results on bases, coordinate representations, and dimension-related theorems. Inner product in Rn, orthogonal and orthonormal sets, orthogonal Matrices, Gram-Schmidt orthonormalization, computing orthonormal basis. Discuss orthogonal complements, derive QR-factorization, and solve least squares and best approximation problems. Introduce linear transformations, compute range and null space, and analyse invertibility. Apply rank-nullity theorem, derive matrix representations, and study change of basis and similarity

concepts. Compute eigenvalues, eigenvectors, characteristic polynomials, and apply the Cayley–Hamilton theorem. Perform matrix diagonalization, analyze positive semidefinite matrices, and study quadratic forms. Present spectral theorem, introduce singular value decomposition, and discuss its computational and geometric applications.

G. Strang, Introduction to linear algebra. Wellesley-Cambridge Press, 2022.
S. H. Friedberg, A. J. Insel, L.E. Spence, Linear Algebra, 4th Edition, Pearson. 2015.
David C. Lay, Linear Algebra and its applications, Pearson, 2022.
Seymour Lipschutz, Marc Lipson, Schaum's Outline of Linear Algebra, McGraw Hill, 6th edition, 2017
W. Cheney, D. Kincaid, Linear Algebra Theory and Applications, Jones & Bartlett, Student Edition. 2010.

MA104N ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORMS (3-0-0) 3

Introduction to differential equations: order, degree, linearity, first-order ODEs, formulation, and interpretation of initial value problems. Separable equations, homogeneous equations, exact equations, reduction to exact form. Integrating factors, first-order linear equations, Reduction to linear form, Bernoulli equation; solving practical problems using these methods. Second-order linear ODEs with constant coefficients; homogeneous cases; real, repeated and complex roots, Superposition principle, solution structure. Second-order nonhomogeneous equations, undetermined coefficients, Wronskian and linear independence of solutions. Second-order variable-coefficient equations, reduction of order if a solution is known, method of variation of parameters, introduction to higher-order linear ODEs. Higher-order linear ODEs. Power series method for solving ODEs about ordinary points, determining radius of convergence, examples of series solutions. Introduction to Laplace Transforms, Laplace transform definition, Elementary properties, standard formulas, inverse Laplace techniques for common functions. Derivative Property of the Laplace Transform, Heaviside unit step function, second shifting theorem, Inverse Laplace Transform, Short impulses, Dirac delta function. Laplace transform of derivatives, differentiation and integration of transforms, solving ODEs using Laplace transforms. Convolution theorem, solution of ODEs using convolution, solution of integral equations using Laplace transforms.

E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley Sons, 2010.
P. Dyke, An Introduction to Laplace Transforms and Fourier Series, 2nd Ed., Springer, 2014
G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw- Hill, 1991
L. Debnath and D. Bhatta, Integral Transforms and Their Applications, CRC Press, 2015.

MA105N PROBABILITY AND STATISTICS (3-0-0) 3

Introduction to probability, Random variables, probability functions. Expectation, variance, Chebyshev inequality. Independence of random variables. Binomial, Poisson, Uniform, Normal. Exponential, Gamma distributions, Functions of random variables. Moments, moment generating functions. Marginal and conditional distributions. Covariance and correlation, Central Limit Theorem. Random samples, statistic, sampling distributions. Chi-square, t and F distributions. Estimation. Properties of the estimators. Statistical Inference.

S. M. Ross, Introduction to probability and statistics for engineers and scientists. Academic press, 2020.
R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, 5th Edition, McMillan, 1995.
D. C. Montgomery and G. C. Runger, Applied statistics and probability for engineers. John Wiley & sons, 2010.
P L Meyer, Introductory Probability and Statistical Applications, Oxford and IBH.

MA106N PARTIAL DIFFERENTIAL EQUATIONS AND FOURIER TRANSFORMS (3-0-0) 3

Basic concepts of ODE and formation of PDEs. Methods to solve simple first order PDEs, Linear operators, Superposition principle. Initial value problem for quasi-linear first order PDEs. Nonlinear PDEs of first order, Cauchy's method of characteristics. Solution of linear 2nd order linear PDEs, Classification of second order linear equations. Fourier series. One-dimensional Heat equation: Modelling and d'Alembert's solution. Heat

equation, Wave equations: Solution by Separation of variables. Laplace equation in Cartesian and spherical coordinates and solution by separation of variables. Fourier transforms, Fourier sine and cosine transforms. Properties of Fourier transforms, convolution theorem. Solve simple PDEs using Fourier transforms.

E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley & Sons, 2010.
L. Debnath and D. Bhatta, Integral Transforms and Their Applications, CRC Press, 2015
I. N. Sneddon, Elements of Partial Differential Equations, Dover Pub Inc., 2006.
Schaum's Outline of Partial Differential Equations

MA107N MULTIVARIABLE CALCULUS (3-0-0) 3

Limit of Functions of one variable and two variables: definition, two-path test. Definition of Continuity and examples. Partial derivatives, differentiability for functions of two and three variables. Gradients, Directional derivatives, Tangents and Normals. Extreme values and saddle points, Lagrange multipliers. Double and triple integrals- Cartesian. Double integral in polar. Triple Integrals in cylindrical and spherical coordinates. Line Integrals, Vector Fields, Work, Circulation, and Flux. Path independence, Potential functions, and Conservative fields. Green's theorem in the plane. Surface Area and Surface Integrals, Parametrized Surfaces. Stokes' theorem, Gauss Divergence Theorem.

G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas Calculus, Pearson Education, 2009.
E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley & Sons, 2010.
S. R. Ghorpade, B. V. Limaye, A Course in Multivariable Calculus and Analysis.

MA108N APPLIED LINEAR ALGEBRA AND GRAPH THEORY (3-0-0) 3

System of linear equations, Gaussian elimination, LU-factorization. Vector spaces, linear independence, basis and dimension. Linear transformations, Rank-nullity theorem. Eigenvalues and eigenvectors, Cayley-Hamilton Theorem. Diagonalization, Spectral theorem. Singular value decomposition. Directed and Undirected graphs, Subgraphs, Isomorphism. Paths and connectedness, Trees. Incidence, Adjacency, Laplacian and distance matrices, their eigenvalues and spectral properties. Methods for computing eigenvalues. Spectrum of some special classes of graphs. The Matrix-tree theorem, intuition of smallest and largest eigenvalues.

G. Strang, Introduction to linear algebra. Wellesley-Cambridge Press, 2022.
D. B. West, Introduction to Graph Theory, Eastern Economy Edition, published by PHI Learning Pvt. Ltd, 2nd Edition, 2002
Bapat, R. B., Graphs and matrices, New York: Springer, 2010.
David C. Lay, Linear Algebra and its applications, Pearson, 2022.

PH100N ENGINEERING PHYSICS (3-0-2) 4

Newton's laws and Galilean transformation, Swimmers in a river, Concept of relative velocity, Michelson-Morley experiment, failure of ether theory, postulates of STR, Consequences of Einstein's postulates - length contraction, time dilation, velocity addition, Lorentz transformations (w/o derivation), spacetime intervals, simultaneity. Length contraction, time dilation, velocity addition from Lorentz transformations, Relativistic energy, momentum, Mass-energy relationship, relativistic system of units, Review of EM waves: interference, diffraction. [Experiments: Set up laser diffraction experiment to determine the wavelength of the laser; Set up Newton's rings (interference) experiment to determine the radius of curvature of a curved surface.], Photoelectric effect – experiment and theory [Experiment: determination of work function of a given photoelectric material], Wien's law, Rayleigh Jeans, Planck's quantum hypothesis and radiation law (w/o derivation), Compton's effect – experiment and theory, de Broglie hypothesis, Davisson-Germer experiment, uncertainty relationship for classical waves, Heisenberg uncertainty principle, wave packets, phase velocity and group velocity, probability and randomness, Properties of waves at boundaries, standing waves in a box; Schrodinger equation, probabilities, normalization [Experiment: Standing wave pattern and resonance

experiments], Infinite potential well, finite potential well (only in 1D), idea of quantum tunnelling (only qualitative) [Experiment on quantum tunnelling in Zener diode.]

Kenneth Krane, Modern Physics, 3rd edition, 2012
Arthur Beiser, Concepts of Modern Physics
Kleppner & Kolenkow, An Introduction to Mechanics, 1st edition, 1973

PH150N ENGINEERING PHYSICS (3-0-2) 4

Review of differential and integral vector calculus: gradient, divergence and curl, Electrostatic field and its calculation in simple cases, Gauss's law and its application, Electrostatic potential, Magnetostatic field and its calculation in simple cases, Lorentz force, Ampere's law and its application, Faraday's law and Maxwell's corrections, final form of Maxwell's equations, Electromagnetic waves in free space, light as an electromagnetic wave [Experiments: Set up laser diffraction experiment to determine the wavelength of the laser beam; Set up Newton's rings (interference) experiment to determine the radius of curvature of a curved surface.], Particle nature of light - Black body radiation, photoelectric effect, Compton Scattering [Experiment: Determination of work function of a given photoelectric material.], Wave nature of particles - de Broglie's hypothesis, Davisson-Germer experiment, Wave packets, Uncertainty principle, Born interpretation, idea of a qubit, Schrodinger Equation [Experiment: Resonance experiment], Particle in an infinite potential well - wavefunction, energy levels, expectation value, Finite potential well, idea of quantum tunnelling (only qualitative) [Experiment: quantum tunnelling in Zener diode]

David Griffiths, Introduction to Electrodynamics, 4th edition, Pearson, 2013
Kenneth Krane, Modern Physics, 3rd edition, 2012
Arthur Beiser, Concepts of Modern Physics.

UC100N DATA SCIENCE AND AI (2-0-2) 3

Introduction to Data Science: Data science workflow, types of data, applications, datasets and features, tabular data representation, descriptive statistics (mean, median, mode, variance, standard deviation, correlation), data cleaning and preprocessing, handling missing and inconsistent data, outlier detection, data transformation and normalization. Linear Algebra for Data Science: Vectors, matrices, matrix operations, transpose, inverse, dot products, linear equations, matrix representation of datasets. Machine Learning Fundamentals: Supervised, unsupervised and reinforcement learning, feature engineering, regression, classification, clustering, evaluation metrics, basics of neural networks and deep learning. Data Visualization and Analysis: Data import, preprocessing, visualization using charts and graphs, exploratory data analysis and interpretation. Artificial Intelligence: AI use cases and applications, AI tools (ChatGPT, Gemini, Copilot, Claude, DALL·E, NotebookLM), chatbot customization, code generation, data analysis, text and image generation, AI ethics, privacy, responsible AI and societal implications. Practicals using Python/MATLAB: Data handling, matrix operations, visualization, preprocessing, data analysis and AI tool applications.

Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking by Foster Provost and Tom Fawcett. O'Reilly Media, 2013.
Mike X. Cohen, Practical Linear Algebra for Data Science, O'Reilly Media, 2022.
ARTIFICIAL INTELLIGENCE Third Edition, by Kevin Knight, Elaine Rich, Shivashankar B. Nair, 2017

UC101N INTRODUCTION TO ENGINEERING (2-0-2) 3

This course introduces students to the fundamental concepts, applications, and career opportunities in major engineering disciplines, including Mechanical, Civil, Chemical, Electrical, Electronics and Communication, Metallurgical and Materials, Mining, Marine, and Ocean Engineering. The course covers basic principles of energy systems, engineering design, water resources, materials, electrical systems, and industrial processes, along with emerging technologies such as Artificial Intelligence (AI), Machine Learning (ML), Industry 4.0, and sustainable engineering practices. Through case studies, laboratory visits, demonstrations, and exposure to

engineering equipment and models, students gain an understanding of the role of engineering in solving real-world problems and contributing to technological and societal development.

K P Roy, S K Hazra Choudhury and Nirjhar Roy, Elements of Mechanical Engineering, Media Promoters and Publishers Pvt Ltd, Mumbai, 2023.
J Wickert, An Introduction to Mechanical Engineering, Cengage learning, 2nd edn. 2006.
Chang, Kang-Tsung. Introduction to geographic information systems. 9th Edition. Boston: McGraw-Hill, 2019.
Subramanya K, Engineering Hydrology, Tata McGraw Hill, 6th Edition, 2024.
Arora, M. K., Geomatics Engineering. 1st Edition. Nem Chand & Bros, 2011.
Ven Te Chow, LW Mays and DR Maidment., Applied Hydrology, McGraw Hill, 1988
Coastal Engineering Manual: Overview and Coastal Hydrodynamics. U. S. Army Corps of Engineers.
S. Pushpavanam (2012), Introduction to Chemical Engineering, Prentice Hall India, New Delhi, India.
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Electrical Engineering Fundamentals, Vincent Del Toro, Publication, 2nd Edition, Pearson India Education, 2015.
Hughes Electrical and Electronic Technology, Edward Hughes (late), John Hiley, Keith Brown, and Ian McKenzie, 12th Edition, Pearson Education India, 2016
Paul Scherz and Simon Monk, "Practical Electronics for Inventors", 4th Edition, McGraw-Hill Education, 2016.
S P Bali, "Consumer Electronics", Pearson India, 2004.
Engineering Materials, An Introduction to their properties and Applications (Second ed., 1996), M F Ashby and D R H Jones, Butterworth; Heinemann Publ. vol 1 & 2
Experimental Techniques in Materials and Mechanics, C Suryanarayana, CRC Press, 2011.
Deshmukh, D.J., Elements of Mining Technology, Vol. I, Denett Publications, Nagpur, 2002.
Hartman H.L, Introductory Mining Engineering, Wiely Interscience, New York, 1987.

UC102N BIOLOGY AND ENVIRONMENT (3-0-0) 3

Biology: Introduction to Biology for Engineers, Human Body as Energy Conversion System, Human Body as a Fluid and Pumping System, Human Body as a Mechanical System, bio-signals, biosensors. Environment: Introduction to marine biology and ecosystem, Interaction between water and ecosystems, Water characteristics, Sources of water pollution, Mitigation Measures, Environmental Impact Assessment, Disaster Resilience, Environmental management tools, Sustainable Energy Sources and Materials, Abiotic and Biotic components of the environment, Impact of air pollution on climate change-GHG.

G. K. Suraishkumar (2019) Biology for Engineers. Oxford University Press; First edition
Bradley Striebig, Adebayo A. Ogundipe, Maria Papadakis, Lauren G. Heine (2023). Environmental Engineering and Sustainable Design, Analysis and Design. CI-Engineering; 2nd edition

UC103N INDIAN KNOWLEDGE SYSTEM (3-0-0) 3

Meaning, scope and relevance of Indian Knowledge Systems (IKS)-Overview of Indian knowledge traditions and sources-Vedic and non-Vedic knowledge systems-Indian philosophy, ethics and worldview-Sanskrit language and knowledge transmission-Indian mathematics, numerals and measurement systems-Indian astronomy, calendars and timekeeping-Traditional metallurgy, material science and technologies-Agriculture, irrigation and traditional water management-Rasayana, traditional medicine and sustainable practices-Indian architecture, Vastu Shastra, temple architecture and town planning-Yoga, Ayurveda and holistic well-being-Indian art, music, dance and aesthetic traditions-Ethical governance, public administration and contemporary relevance of IKS.

Mahadevan, B., Vinayak Raj Bhat, and Nagendra Pavana R.N. (2022). Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning.
Kapoor, Kapil, and Avadhesh Kumar Singh, eds. (2005). Indian Knowledge Systems. D.K. Printworld.
Bansal, Gagan. (2022). Indian Knowledge System: Integrating Heritage with Engineering. Deep Science Research

Department of Physical Education and Life-Skills (PL)

Physical Activity Courses

PL110N	Introduction to Physical Activities - 1	(0-0-2)1
PL119N	NCC-Physical Activity -1	(0-0-2)1
PL150N	Introduction to Physical Activities - 2	(0-0-2)1
PL159N	NCC-Physical Activity -2	(0-0-2)1
PL211N	Athletics - 1	(0-0-2)1
PL212N	Indoor Games - 1	(0-0-2)1
PL213N	Field Games - 1	(0-0-2)1
PL214N	Net Games - 1	(0-0-2)1
PL215N	Martial Arts - 1	(0-0-2)1
PL216N	Strength Sports - 1	(0-0-2)1
PL217N	Water Sports - 1	(0-0-2)1
PL218N	Indigenous Sports - 1	(0-0-2)1
PL219N	NCC – Physical Activities - 3	(0-0-2)1
PL251N	Athletics - 2	(0-0-2)1
PL252N	Indoor Games - 2	(0-0-2)1
PL253N	Field Games - 2	(0-0-2)1
PL254N	Net Games - 2	(0-0-2)1
PL255N	Martial Arts - 2	(0-0-2)1
PL256N	Strength Sports - 2	(0-0-2)1
PL257N	Water Sports - 2	(0-0-2)1
PL258N	Indigenous Sports - 2	(0-0-2)1
PL259N	NCC – Physical Activities - 4	(0-0-2)1
PL311N	Athletics - 3	(0-0-2)1
PL312N	Indoor Games - 3	(0-0-2)1
PL313N	Field Games - 3	(0-0-2)1
PL314N	Net Games - 3	(0-0-2)1
PL315N	Martial Arts - 3	(0-0-2)1
PL316N	Strength Sports - 3	(0-0-2)1
PL317N	Water Sports - 3	(0-0-2)1
PL318N	Indigenous Sports - 3	(0-0-2)1
PL319N	NCC – Physical Activities - 5	(0-0-2)1

Cultural Activity Courses

PL120N	Introduction to Cultural Activities - 1	(0-0-2)1
PL129N	NCC-Cultural Activity - 1	(0-0-2)1
PL160N	Introduction to Cultural Activities - 2	(0-0-2)1
PL169N	NCC-Cultural Activity - 2	(0-0-2)1
PL221N	Culinary Arts - 1	(0-0-2)1
PL222N	Dance - 1	(0-0-2)1
PL223N	Fashion Design - 1	(0-0-2)1
PL224N	Film Making - 1	(0-0-2)1
PL225N	Literature & Stage - 1	(0-0-2)1
PL226N	Music -1	(0-0-2)1
PL227N	Painting - 1	(0-0-2)1
PL228N	Sculpting - 1	(0-0-2)1
PL229N	NCC-Cultural Activity - 3	(0-0-2)1
PL261N	Culinary Arts - 2	(0-0-2)1
PL262N	Dance - 2	(0-0-2)1
PL263N	Fashion Design - 2	(0-0-2)1
PL264N	Film Making - 2	(0-0-2)1
PL265N	Literature & Stage - 2	(0-0-2)1
PL266N	Music -2	(0-0-2)1
PL267N	Painting - 2	(0-0-2)1
PL268N	Sculpting - 2	(0-0-2)1
PL269N	NCC-Cultural Activity - 4	(0-0-2)1
PL321N	Culinary Arts - 3	(0-0-2)1
PL322N	Dance - 3	(0-0-2)1
PL323N	Fashion Design - 3	(0-0-2)1
PL324N	Film Making – 3	(0-0-2)1
PL325N	Literature & Stage – 3	(0-0-2)1
PL326N	Music – 3	(0-0-2)1
PL327N	Painting – 3	(0-0-2)1
PL328N	Sculpting – 3	(0-0-2)1
PL329N	NCC-Cultural Activity – 5	(0-0-2)1

Technical Activity Courses

PL130N	Introduction to Technical Activities - 1	(0-0-2)1
PL139N	NCC-Technical Activity - 1	(0-0-2)1
PL170N	Introduction to Technical Activities - 2	(0-0-2)1
PL179N	NCC-Technical Activity - 2	(0-0-2)1
PL231N	Air/Space Vehicle - 1	(0-0-2)1
PL232N	Ground Vehicle - 1	(0-0-2)1
PL233N	Marine Vehicle - 1	(0-0-2)1
PL234N	Educational Toy - 1	(0-0-2)1
PL235N	Farming & Food - 1	(0-0-2)1
PL236N	Smart Home - 1	(0-0-2)1
PL237N	Sustainability - 1	(0-0-2)1
PL238N	Wearable Device -1	(0-0-2)1
PL239N	NCC-Technical Activity - 3	(0-0-2)1
PL271N	Air/Space Vehicle - 2	(0-0-2)1
PL272N	Ground Vehicle - 2	(0-0-2)1
PL273N	Marine Vehicle - 2	(0-0-2)1
PL274N	Educational Toy - 2	(0-0-2)1
PL275N	Farming & Food - 2	(0-0-2)1
PL276N	Smart Home - 2	(0-0-2)1
PL277N	Sustainability - 2	(0-0-2)1
PL278N	Wearable Device -2	(0-0-2)1
PL279N	NCC-Technical Activity - 4	(0-0-2)1
PL331N	Air/Space Vehicle - 3	(0-0-2)1
PL332N	Ground Vehicle - 3	(0-0-2)1
PL333N	Marine Vehicle - 3	(0-0-2)1
PL334N	Educational Toy - 3	(0-0-2)1
PL335N	Farming & Food - 3	(0-0-2)1
PL336N	Smart Home - 3	(0-0-2)1
PL337N	Sustainability - 3	(0-0-2)1
PL338N	Wearable Device -3	(0-0-2)1
PL339N	NCC-Technical Activity - 5	(0-0-2)1

Professional Activity Courses

PL140N	Professional Communication - 1	(0-0-2)1
PL149N	NCC-Professional Communication - 1	(0-0-2)1
PL180N	Professional Communication - 2	(0-0-2)1
PL189N	NCC-Professional Communication - 2	(0-0-2)1
PL240N	Professional Communication - 3	(0-0-2)1
PL249N	NCC-Professional Communication - 3	(0-0-2)1
PL280N	Professional Communication - 4	(0-0-2)1
PL289N	NCC-Professional Communication - 4	(0-0-2)1
PL340N	Professional Communication - 5	(0-0-2)1
PL349N	NCC-Professional Communication - 5	(0-0-2)1

PL110N, PL120N, PL130N, PL140N are first semester common courses

PL119N, PL129N, PL139N, PL149N are first semester common courses for NCC students

PL150N, PL160N, PL170N, PL180N are second semester common courses

PL159N, PL169N, PL179N, PL189N are second semester common courses for NCC students

Suggested Plan of Study for Life-Skill Activities

.	I	II	III	IV	V	VI	VII	VIII
1	PL110N/ PL119N	PL150N/ PL159N	PL211N/ PL212N/ PL213N/ PL214N/ PL215N/ PL216N/ PL217N/ PL218N/ PL219N	PL251N/ PL252N/ PL253N/ PL254N/ PL255N/ PL256N/ PL257N/ PL258N/ PL259N	PL311N/ PL312N/ PL313N/ PL314N/ PL315N/ PL316N/ PL317N/ PL318N/ PL319N			
2	PL120N/ PL129N	PL160N/ PL169N	PL221N/ PL222N/ PL223N/ PL224N/ PL225N/ PL226N/ PL227N/ PL228N/ PL229N	PL261N/ PL262N/ PL263N/ PL264N/ PL265N/ PL266N/ PL267N/ PL268N/ PL269N	PL321N/ PL322N/ PL323N/ PL324N/ PL325N/ PL326N/ PL327N/ PL328N/ PL329N			
3	PL130N/ PL139N	PL170N/ PL179N	PL231N/ PL232N/ PL233N/ PL234N/ PL235N/ PL236N/ PL237N/ PL238N/ PL239N	PL271N/ PL272N/ PL273N/ PL274N/ PL275N/ PL276N/ PL277N/ PL278N/ PL279N	PL331N/ PL332N/ PL333N/ PL334N/ PL335N/ PL336N/ PL337N/ PL338N/ PL339N			
4	PL140N/ PL149N	PL180N/ PL189N	PL240N/ PL249N	PL280N/ PL289N	PL340N/ PL349N			

Physical Activities

PL110N INTRODUCTION TO PHYSICAL ACTIVITIES - 1 (0-0-2) 1

Introduction to four physical activities out of eight activities. Introduction to the remaining four activities is part of PL150N in the second semester.

Athletics: Running/Jumping/Throwing/Obstacle etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc. *Indoor Games*: Chess/Carroms/Table Tennis/Archery etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc. *Field Games*: Cricket/Football/Handball/Basketball etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, *Assignment, Evaluation, etc. Football*: Origin & History: Ancestral Roots, Global Spread, Cultural Impact. Key Personalities & Leadership *Models. Fundamentals of the Game*: Ball Control & Striking Mechanics, Spatial Geometry & Support Play, Defensive Body Positioning, Scanning & Decision-Making. *The International Football Association Board (IFAB). Laws of the Game. Official Annual Rulebook Luxbacher, J. A. (2014). Soccer: Steps to Success. Human Kinetics.*
Net Games: Badminton/Ball Badminton/Volleyball/Lawn Tennis etc - Origin & History, evolution of the sport, national and international development, governing bodies, major tournaments Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Martial Arts: Lathi/Kalari/Karate/Taekwondo etc - Taekwondo -Introduction to Taekwondo safety rules, practice discipline, warm-up, cool-down and basic flexibility; standing posture, ready position, simple stances and stepping; low and middle blocks, straight punch and front-kick preparation; supervised non-contact practice with emphasis on fitness, balance, coordination and safe movement.
Strength Sports: Bodybuilding/Weightlifting/Powerlifting/Yoga etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc. Yoga: Level 1 Classical Hatha Yoga Practices-Upa *Yoga series*: Yoga Namaskar, Thorpukarnam Meditations.
Water Sports: Swimming/Water Polo/Kayaking/Surfing etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Indigenous Sports: Kabaddi/Kho-Kho/NSS etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc

PL119N NCC - PHYSICAL ACTIVITY - 1 (0-0-2) 1

Orientation to NCC physical training standards, safety briefing, warm-up and cool-down routines. Basic calisthenics. Foundational running technique and baseline 1.6 km timed run assessment. Flexibility, stretching routines, and joint mobility exercises for injury prevention and recovery. Introduction to team sports, athletics, and yoga. Rope skipping and agility-ladder drills for coordination, footwork, and rhythm. Basic obstacle course training: low hurdles, crawling, and balance beam elements. remedial practice, and semester-end fitness evaluation.

Directorate General NCC (DGNCC) - NCC Cadet's Handbook. R.K. Gupta - NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations.

PL150N INTRODUCTION TO PHYSICAL ACTIVITIES - 2 (0-0-2) 1

Introduction to four physical activities out of eight activities. Introduction to the remaining four activities is part of PL110N in the first semester.

Athletics: Running/Jumping/Throwing/Obstacle etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc.

Indoor Games: Chess/Carroms/Table Tennis/Archery etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc.
Field Games: Cricket/Football/Handball/Basketball etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc. Football: Origin & History: Ancestral Roots, Global Spread, Cultural Impact. Key Personalities & Leadership Models. Fundamentals of the Game: Ball Control & Striking Mechanics, Spatial Geometry & Support Play, Defensive Body Positioning, Scanning & Decision-Making.
Net Games: Badminton/Ball Badminton/Volleyball/Lawn Tennis etc - Origin & History, evolution of the sport, national and international development, governing bodies, major tournaments Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Martial Arts: Lathi/Kalari/Karate/Taekwondo etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc. Taekwondo : Reinforcement of the basic Taekwondo foundation, including safety, discipline, warm-up, cool-down, flexibility, standing posture, ready position, simple stances and stepping, low and middle blocks, straight punch and front-kick practice; repeated supervised non-contact practice for improved balance, control and confidence.
Strength Sports: Bodybuilding/Weightlifting/Powerlifting/Yoga etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc. Yoga: Level 1 Classical Hatha Yoga Practices-Upa Y*oga series*: Yoga Namaskar, Thorpukarnam Meditations.
Water Sports: Swimming/Water Polo/Kayaking/Surfing etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Indigenous Sports: Kabaddi/Kho-Kho/NSS etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc

PL159N NCC-PHYSICAL ACTIVITY -2 (0-0-2) 1

Fitness performance review and individual goal setting. Progressive calisthenics with increased repetitions, core strengthening, and plank routines. 1.6 km run with improved pace targets, push-ups, and chin-ups. Basic swimming orientation and water-safety awareness. Introduction to court games and field games. Basic yoga asanas and breathing (pranayama) exercises for stamina and mental focus. Team-building games and coordination-based group physical activities. Principles of strength and conditioning, endurance circuit training, inter-team fitness challenges, and semester-end assessment.

Directorate General NCC (DGNCC) - NCC Cadet's Handbook. R.K. Gupta - NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations.

PL211N ATHLETICS - 1 (0-0-2) 1

[Running/Jumping/Throwing etc.]

Running: Multi-directional warm-ups; advanced Running ABC drills (High-knees, A- skips). Stride length vs. frequency adjustments; linear hip alignment drills. Reaction time training; responsive drills for the Standing Start position. Structural mechanics of the Crouch Start; torso and limb angle distribution. Starting Block Setup: Adjusting front/rear pedals for individual body builds. Starting block execution: Practicing the "On your marks" and "Set" response mechanics. The Drive Phase: Staying low during the initial 10m to 15m out of the blocks. Transition phase: Gradual torso lift to achieve full maximum velocity mechanics. Maximum velocity maintenance; front-side arm swing and high knee lift. Speed endurance intervals; running repeated high-intensity 60m and 80m zones. Finishing Techniques: Stridework for the Run-Through, Forward Lean, and Shoulder Shrug. Performance Trial: Timed 100m block sprint from standard starting blocks.
Health and Physical Education by K. Puri and S.S. Chandra, Surjeet Publications.
The Mechanics of Athletics by Geoffrey Dyson.
Anatomy for Strength and Fitness Training by Mark Vella.

Jumping: Fundamentals of single-leg and two-foot take-off mechanics, flight-phase body control, and shock-absorbing landing techniques; basic jump variations — vertical leap, standing broad jump, low-impact line hops, and basic jump rope timing; take-off practice using floor markers and soft mats for accuracy and height/distance drills; progressive approach-step coordination, knee drive, and cushioned landing drills at varying distances; partner stability and reaction-jump challenges; and dynamic coordination games such as obstacle hop relays and distance-landing targets.

Puri, K., & Chandra, S.S. Health and Physical Education. Surjeet Publications.

Dyson, G. The Mechanics of Athletics.

Throwing: Fundamentals of underarm and overarm throwing technique, hand-eye coordination and safe handling of throwing equipment; basic grips — overhand, underhand and two-hand grip; underarm throw practice with bean bags at stationary targets and accuracy drills at varying distances; overarm throw technique with step-throw coordination and distance practice; partner throw-catch drills; and reaction and coordination games such as throw-catch relays.

IAAF/World Athletics Technical Manual — Throwing Events (Shot Put, Discus, Javelin, Hammer)

Bunn, J. W., Scientific Principles of Coaching, Prentice Hall

SAI (Sports Authority of India) Coaching Manual — Athletics: Throws

PL212N INDOOR GAMES - 1 (0-0-2) 1

[Chess/Carroms/Table Tennis etc.]

Chess: History of the game, board setup, piece movement and the essential rules of play; algebraic notation, score sheets, etiquette and the chess clock; opening principles and a basic repertoire with both colours; tactical motifs, mating patterns and systematic calculation; position evaluation, pawn structures, piece quality, prophylaxis, attack and defence; essential and advanced endgames; game analysis and annotation using databases and engines; FIDE Laws of Chess, pairings, tie-breaks and basic arbiting; opponent preparation, time management, team chess and captaincy; practice games, rated tournaments and post-mortems.

Fischer, B., Margulies, S. and Mosenfelder, D., Bobby Fischer Teaches Chess, Bantam Books, 1982.

Silman, J., How to Reassess Your Chess, 4th ed., Siles Press, 2010.

de la Villa, J., 100 Endgames You Must Know, 5th ed., New in Chess, 2019.

FIDE, FIDE Handbook: Laws of Chess, Fédération Internationale des Échecs, latest edition (fide.com).

Carroms: Review of fundamental skills and performance improvement; Advanced Cut, Rebound and Side Shots; Striker Positioning and positional control; Break Techniques and strategy; Evaluation & Practical Assessment; Queen Pocketing and Cover Strategy; Attacking and Defensive Strategies; Decision-Making and Shot Planning; Singles & Doubles Practice Matches: Tactical play, teamwork, concentration, and sportsmanship.

Table Tennis: Introduction to table tennis, grip, stance and basic footwork, the forehand and backhand counters, side-step and pivot movement, the principles of spin and the push, the drive and the smash, the basic services and receives, the forehand topspin with its footwork, blocking, and the rules of the game. Push variations, topspin against backspin, topspin variations, the backhand counter topspin, punch and drive, three-position and Falkenberg footwork, and doubles play with rotation footwork. Advanced backhand, pendulum, tomahawk and lollypop serves and their receives, the first five balls and point construction, the characteristics of long, short and anti-spin pimple rubbers and the technique for playing against them, strategy against attacking, all-round and defensive players, umpiring, and the planning, organisation and video analysis of an open tournament.

McAfee, R. (2009), Table Tennis: Steps to Success, Human Kinetics; Heaton, J. (2009), Table Tennis: Skills, Techniques, Tactics, The Crowood Press; Zhu, K. & Xu, L. (2022), Journal of Healthcare Engineering, 2022(1), 8392683.

PL213N FIELD GAMES - 1 (0-0-2) 1

[Cricket/Football/Basketball etc.]

Cricket: Fundamentals and advanced techniques of batting, pace and spin bowling, catching, throwing, fielding, and wicket-keeping; umpiring, scoring, and equipment specifications; shot selection, power hitting, and advanced bowling variations; captaincy, match tactics, and strategies based on score and pitch conditions.
Basics of Cricket; Dr.R. Ram Mohan Singh; BlueRose Publishers Pvt. Ltd.;2024.
Cricket: The Definitive Guide to International Cricket; Harsha Bhogle (Foreword), John Stern (Author) ; Parragon Book Service Ltd; 2015.
Football: Laws of the Game: In-depth look at the International Football Association Board Laws of the game (fouls, misconduct, offside rule, and restarts). Pitch Dynamics: Pitch dimensions and functional markings of the football field (penalty box, technical areas, arcs). Push Pass Mechanics: Mastering kicking with the inside of the foot for short-range accuracy. Power Passing & Shooting: Introduction to kicking with the instep of the foot (laces) for distance and velocity. Swerve & Alternative Striking: Kicking with the outer instep of the foot to generate outward spin and trajectory changes Ground Control (Inside): Trapping and absorbing the momentum of the ball using the inside of the foot. Ground Control (Instep): Trapping and cushioning low-driven balls using the instep of the foot. Dynamic Ball Control: Trapping bouncing or dropping balls using the sole of the foot to kill ball momentum instantly. Linear Dribbling Mechanics: Developing dribbling sequences using the instep and the inside of the foot for directional security. Combining Pass & Move: Integrated drills combining inside-foot passing with immediate sole/instep trapping under light opposition pressure. End-Semester Practical Evaluation.
The International Football Association Board (IFAB). Laws of the Game. Official Annual Rulebook
Luxbacher, J. A. (2014). Soccer: Steps to Success. Human Kinetics.
Coyle, D. (2009). The Talent Code: Greatness Isn't Born. It's Grown. Here's How. Bantam Books.
Basketball: Team formations, Offensive systems, Defensive formations, Pick and roll, Zone defense, Man-to-man defense, Fast transition, Communication drills, Match analysis, Practice games, Inter-group matches, Assessment
FIBA e-Learning.
Jerry V. Krause & Don Meyer, Basketball Skills & Drills (3rd ed.), Human Kinetics, 2008.

PL214N NET GAMES - 1 (0-0-2) 1

[Badminton/Ball Badminton/Volleyball etc.]

Badminton: Basic Service Techniques – Forehand serve, backhand serve, short serve, long serve, service rules, consistency, and target practice. Physical Conditioning – Agility ladder drills, balance exercises, flexibility, coordination, reaction time, endurance training, and badminton-specific fitness. Basic Grip and Ready Position – Forehand grip, backhand grip, grip changes, ready stance, racket handling, body posture, and shadow practice. Fundamental Footwork – Split step, forward, backward and lateral movement, lunge techniques, recovery to base position, and court coverage drills. Basic Service Techniques – Forehand serve, backhand serve, short serve, long serve, service rules, consistency, and target practice. Basic Stroke Techniques – Forehand clear, backhand clear, drive, lift, and follow-through mechanics Net Play Fundamentals – Net shot, net lift, net approach, shuttle control, soft touch, and recovery movement. Overhead Stroke Fundamentals – Drop shot, overhead clear, basic smash technique, timing, and body coordination. Skill Integration – Multi-shuttle drills, movement with strokes, consistency drills, partner rallies, and accuracy exercises. Introduction to Singles and Doubles – Court positioning, rotation, communication, scoring practice, and basic tactics. Practice Match Sessions – Modified singles and doubles match, skill observation, performance feedback, and correction of errors. Fundamental Skill Assessment – Practical assessment of grips, footwork, serves, strokes, rules, scoring, and modified match participation.
Jain, A. (2005). Badminton Coaching Manual. Jain Media Graphics, New Delhi, India.
Beal, D. (2011). Badminton: A Guide for Beginners. Crowood Press, Ramsbury, UK.
Singh, M. K. (2007). Comprehensive Badminton. Friends Publications (India), New Delhi.

Badminton World Federation (BWF). BWF Coach Education Level 1 – Coaches' Manual. Badminton World Federation, Kuala Lumpur, Malaysia.

Ball Badminton: Introduction, Proper racket grip techniques, ready stance; Basic footwork drills, including forward, backward, and lateral movement. Introduction to the Underhand Serve and serving regulations; Execution of the Forehand Push, Backhand Push, basic overhead clear and defensive positioning; Court boundaries, scoring, and basic faults; Introduction to doubles positioning and the "front-and-back" system; Low-intensity rallying drills; Introduction to Net Play, including basic drops and tappings; Physical conditioning tailored for agility, speed, and wrist flexibility; Intramural recreational singles matches.

Ball Badminton: A Complete Reference to India's Indigenous Racket Sport

Ball Badminton An Indian Racket Game: A Complete Guide to Its History, Rules, and Mastering Techniques

Official Rule Book and Guide to Ball Badminton (Ball Badminton Federation of India / Academic Institutional Manuals)

Volleyball: Introduction and fundamentals of volleyball. Students will learn the history and development of volleyball, court dimensions and markings, equipment, basic rules and regulations, scoring system, player positions, rotation, and basic officiating. Practical sessions will emphasize ready position, footwork, underhand passing, overhand passing, basic setting, underhand service, ball control, and elementary defensive movements. Students will also participate in basic drills and modified games to develop coordination, agility, flexibility, teamwork, and sportsmanship.

FIVB, Official Volleyball Rules, Fédération Internationale de Volleyball.

Donald C. Shondell and Cecile Reynaud, The Volleyball Handbook, Human Kinetics.

American Volleyball Coaches Association, Volleyball Skills & Drills, Human Kinetics.

PL215N MARTIAL ARTS - 1 (0-0-2) 1

[Karate/Taekwondo etc.]

Karate: Development of balance, foot movement and body control through forward, backward and lateral movement; practice of straight and reverse punches, downward, middle and rising blocks, front kick and knee-control exercises; simple punch-block-kick combinations, safe partner-distance drills, basic self-defence awareness and short non-contact sequences.

Taekwondo: Development of body balance, coordination and controlled movement through revision of stances, stepping, guard position and breathing; practice of low, middle and high blocks, basic punches, front kick and controlled round-kick preparation; soft target-pad practice, simple block-punch and kick-punch combinations, and short non-contact sequences.

PL216N STRENGTH SPORTS - 1 (0-0-2) 1

[Weightlifting/Powerlifting/Yoga etc.]

Weightlifting: Gym orientation, platform safety and lifting etiquette; equipment usage and familiarization; shoulder, hip and ankle mobility drills; overhead squat and front-rack positional technique; snatch grip drills and high pulls; snatch balance and overhead catch position; clean grip and rack position drills; clean pull technique and first-pull mechanics; jerk footwork and dip-drive mechanics; empty-bar snatch and clean & jerk walkthrough; mobility warm-up and cool-down routines; loading progressions and plate math; muscle snatch and snatch-pull technique; power snatch technique with light load; muscle clean and clean-pull technique; power clean and push-press technique; full snatch from the floor with light load; full clean & jerk from the floor with light load; split-jerk footwork refinement; common fault correction such as early arm bend and looping bar path; video review and technique tracking.

Everett, G., "Olympic Weightlifting: A Complete Guide for Athletes & Coaches."

Bompa, T.O. & Haff, G.G., "Periodization: Theory and Methodology of Training," Human Kinetics.

International Weightlifting Federation, "Technical and Competition Rules." Drechsler, A., "The Weightlifting Encyclopedia."

American College of Sports Medicine, Position Stand: "Progression Models in Resistance Training."

Powerlifting: Building on the orientation provided, students learn correct lifting mechanics using a PVC pipe or light rod as a technique-training tool. The semester begins with a review of safety practices before progressing through the hip-hinge movement pattern and air-squat technique. Students practise the squat, deadlift and bench-press movement patterns using the PVC pipe, and are introduced to spotting techniques, resistance-band exercises and medicine-ball handling drills.
International Powerlifting Federation (IPF) Technical Rules Handbook, Latest Edition.
NSCA-Essentials of Strength Training and Conditioning, Latest Edition, Human Kinetics.
ACSM's Guidelines for Exercise Testing and Prescription
Introduction to Exercise Physiology & Sports Performance – IIT Madras
Yoga: Classical Hatha Yoga Practices-Angamardana Standing Series. Angamardana Squatting Series. Angamardana Sitting Series. Angamardana Lying Series. Invocation, related videos. Upa Yoga practices. Main Hatha Yoga practice. Meditation / Relaxation. Questions, reflections and sharing

PL217N WATER SPORTS - 1 (0-0-2) 1

[Swimming]

Swimming: Orientation & Water Familiarization: Assessment of core balance, body alignment, and buoyancy control. Freestyle Fundamentals: Body roll, kick timing, continuous arm recovery, and hand entry. Freestyle Breathing & Rhythms: Bilateral breathing techniques, head rotation, and short-distance consistency. Backstroke Mechanics: Head positioning, horizontal body posture, flutter kick on back, and continuous arm stroke. Freestyle & Backstroke Turns: Open turns, flip turn progression (wall approach, somersault, push-off, streamline), and back-to-breast transitions. Breaststroke Fundamentals: Whip kick mechanics, glide phase synchronization, and head/chest elevation timing. Breaststroke Breathing & Pull: High-elbow insweep, explosive arm pull, recovery, and timing the "kick-glide-pull" cycle. Butterfly Fundamentals: Dolphin kick mechanics (undulation from core/hips), surface kick efficiency, and vertical kick drills. Butterfly Stroke & Timing: Simultaneous arm recovery, 2-kick per stroke rhythm, and low-profile breathing. Short-Distance Consistency & Drill Demonstration: Practical drill execution for stroke efficiency, distance per stroke (DPS), and pacing over certain distance.

PL218N INDIGENOUS SPORTS - 1 (0-0-2) 1

[Kabaddi/Kho-Kho/NSS etc.]

Kabaddi: Advanced Performance Profiling – Fitness testing, skill audit and individualized improvement goals. Advanced Raiding – Multi-directional footwork, running hand touch combinations and raid timing. Dubki and Escape Mastery – Advanced dubki, kick, body evasion and recovery techniques. Do-or-Die Raids – Risk assessment, defender reading, scoring probability and safe execution. Advanced Bonus Strategy – Bonus decisions, defender positioning and raid sequencing. Advanced Defence – Coordinated ankle hold, block, dash and corner-cover techniques. Chain and Combination Defence – Timing, communication, trapping space and coordinated tackles. Super Tackle and Revival Strategy – Numerical disadvantage situations and tactical recovery. Transition and Counterplay – Immediate defensive conversion, counter-raids and positional recovery. Video/Tactical Analysis – Opponent observation, pattern recognition, match planning and feedback. Competitive Practice – Structured league and knockout matches with performance analysis. Advanced Assessment – Technical, tactical, fitness and leadership assessment through match play.
Kho-Kho: Familiarity with the playing field, poles, central lane, cross lanes, free zones, player positions, fundamental terminology, and basic rules. Techniques of acceleration, balance, change of direction, reaction time, body posture, and energy expenditure are introduced through simple demonstrations. Basic chasing and defending skills - progressive exercises, demonstrations, modified games, and team activities. Focus on - safe participation, physical preparedness, communication, discipline, sportsmanship, and enjoyment of the game.
How to Learn Kho-Kho, by M.S. Tyagi, Dr. Shubhra Kathuria, and Sheetal Chauhan
KHO KHO FROM MUD TO MAT, by Man Singh, Ashwani R and Anil Lumar
NSS:

Fundamentals of NSS, Water conservation awareness program, Campus water audit activity, Blood donation awareness campaign/ Independence Day participation, Health awareness program in adopted village, Disaster preparedness training, Rakshin Level III training program, Beti Bachao Beti Padhao outreach activity, Village adoption fieldwork activity, Participation in institute activities, Community interaction and reporting activity, Two-day NSS special tour and activity evaluation.

PL219N NCC – PHYSICAL ACTIVITIES - 3 (0-0-2) 1

High-intensity endurance conditioning; 3 km timed run assessment. Athletics, Clear Jump, High Wall (6 ft), Straight Balance, Ramp. Intermediate Yoga: Vrikshasana, Dhanurasana, Paschimottanasana, and deep breathing for recovery. Specialised team sports training: Position-specific training, tactical formations. 5 km tempo run evaluation, trekking, and cross-country.

Directorate General NCC (DGNCC) - NCC Cadet's Handbook. R.K. Gupta - NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations.

PL251N ATHLETICS - 2 (0-0-2) 1

[Running/Jumping/Throwing etc.]

Running: Aerobic capacity mapping; establishing split training tempos over mid-distances. Interval Tracking: Managing pacing shifts and oxygen debt indicators. Recovery management; training to handle the "Second Wind" during distance running. Hurdling Mechanics: Mechanical drills isolating the lead-leg drive step. Hurdling Mechanics: Drilling the trail-leg sweep and quick touchdown execution. Stride integration: Establishing consistent 3-stride or 5-stride steps between hurdles. Relay Basics: Core rules for baton handling and stationary hand targets. Non-Visual Exchange: Handoff mechanics for high-speed. Visual Exchange: Controlled passing methods. Zone optimization: Using the full 30m relay exchange zone to match teammate speed. Speed endurance under pressure: Running hurdle flights and relay curves at race pace. Performance Trial: relay team trial and a 4-hurdle clearance test.
Jumping: Core and spinal flexibility conditioning; back arching mat drills. Introduction to the High Jump approach; setting the curved J-Runway path. Centrifugal force mastery; maintaining posture lean along the J-curve approach. High Jump Takeoff: Converting linear momentum into explosive vertical lift. Bar clearance physics: Training hip elevation and head-back tracking forms. The *Fosbury Flop*: Integrating full approach runs with over-the-bar back rotation. Alternative vertical forms: Historical drills focusing on the Straddle Pole Vault foundations: Learning basic pole grips and carrying alignments. Pole Vault plant mechanics: The approach run coupled with the low box plant step. Vertical safety forms: Managing standard impact dispersion on landing mats. Progressive vertical adjustments: Handling high bar heights and clearing check marks. Performance Trial: Measured High Jump crossbar performance test.
Throwing: Core, shoulder and arm conditioning for throwing using medicine-ball and resistance-band work; target throwing with fixed and moving targets; distance throwing through the two-hand chest-pass throw; push-throw technique with a light medicine ball in shot-put style; introduction to rotational throwing through standing spin imitation and safety spacing drills; and team throwing games including dodgeball-style activities and an introduction to throwball rules and positioning.
IAAF/World Athletics Technical Manual — Throwing Events (Shot Put, Discus, Javelin, Hammer)
Bunn, J. W., Scientific Principles of Coaching, Prentice Hall
SAI (Sports Authority of India) Coaching Manual — Athletics: Throws

PL252N INDOOR GAMES - 2 (0-0-2) 1

[Chess/Carroms/Table Tennis etc.]

Chess: History of the game, board setup, piece movement and the essential rules of play; algebraic notation, score sheets, etiquette and the chess clock; opening principles and a basic repertoire with both colours; tactical motifs, mating patterns and systematic calculation; position evaluation, pawn structures, piece quality,

prophylaxis, attack and defence; essential and advanced endgames; game analysis and annotation using databases and engines; FIDE Laws of Chess, pairings, tie-breaks and basic arbiting; opponent preparation, time management, team chess and captaincy; practice games, rated tournaments and post-mortems.

Fischer, B., Margulies, S. and Mosenfelder, D., Bobby Fischer Teaches Chess, Bantam Books, 1982.
Silman, J., How to Reassess Your Chess, 4th ed., Siles Press, 2010.
de la Villa, J., 100 Endgames You Must Know, 5th ed., New in Chess, 2019.
FIDE, FIDE Handbook: Laws of Chess, Fédération Internationale des Échecs, latest edition (fide.com).

Carroms: Match assessment and performance analysis; Advanced Striking: Cut, rebound, side and combination shots; Board Positioning and Break Strategy; Sequential Shot Planning and striker control; Evaluation & Assessment; Attacking and Defensive Strategies; Opponent Analysis and Tactical Decision-Making; Pressure Management and Consistency; Singles & Doubles Competitive Practice: Strategy, teamwork and leadership; Rules, Scoring, Officiating and Match Etiquette.

Table Tennis: Introduction to forehand flick and its types; in and out combination footwork with forehand flick and topspin/drive, introduction to backhand flick and its types; in and out combination footwork with backhand flick and counter/drive, types of push and its variations; combination drills on push and topspins, introduction to forehand and backhand topspin for backspin ball, variations of topspins [no spin, smashed, lateral, counter spin, topspin on topspin], introduction to backhand counter topspin, backhand punch and drive, three position topspin drills towards forehand and backhand corners alternatively, introduction to long footwork [falkenberg footwork] and random free drills on the falkenberg sequence, drills on combination workout of random free balls and middle ball [c-f-c-b, c-b-c-f, c-f], drills on push, topspin and block followed by smash/topspin to different locations and free play, introduction to doubles play and rotation footwork for doubles, team and doubles match formats, types and tournament organisation.

PL253N FIELD GAMES - 2 (0-0-2) 1

[Cricket/Football/Handball/Basketball etc.]

Cricket: Cricket biomechanics and performance analysis; sports psychology and nutrition; strength, speed, and agility training; injury prevention, rehabilitation, and recovery; performance analytics and sports technology; and skill and fitness assessment.

Basics of Cricket; Dr.R. Ram Mohan Singh; BlueRose Publishers Pvt. Ltd.;2024.
Cricket: Training and Conditioning for Cricket; Alan Pearson; Bloomsbury Sport; 2016

Football: Lofted Kicks & Chips: Executing long-range lofted kicks for clearance and delicate chips to bypass defensive blocks. Swivel & Swing Distributions: Perfecting the mechanics of in-swing and out-swing delivery patterns. Aerial Volleys: Mechanics of the full volley. Drop Volleys: Executing the half volley Speed Dribbling Circuits: Transitions between controlled, tight-space dribbling and high-velocity fast dribbling. Mid-Semester Practical Evaluation. Evasive Dribbling Layouts: Straight line vs zig-zag dribbling patterns emphasizing high-speed foot changes. Obstacle Navigation: Precision dribbling between structural obstacles and defenders in tight channels. Mid-Body Ball Reception: Trapping and decelerating incoming aerial balls using the abdomen and shin zones. Upper-Leg Reception: Cushioning dropping balls using the thigh to bring the ball into an immediate playing position. Aerial Torso Control: Chest trapping mechanics. End-Semester Practical Evaluation

The International Football Association Board (IFAB). Laws of the Game. Official Annual Rulebook
Luxbacher, J. A. (2014). Soccer: Steps to Success. Human Kinetics.
Coyle, D. (2009). The Talent Code: Greatness Isn't Born. It's Grown. Here's How. Bantam Books.

Basketball: Advanced dribbling, Advanced shooting, Defensive rotations, Offensive plays, Screen setting, Transition offense, Match strategy, Conditioning, Scrimmages, Tournament preparation, Practice tournament, Evaluation.

Basketball Fundamentals – Jay Dawes
National Basketball Conditioning Coaches Associations (NBCCA), Complete Conditioning for Basketball, Human Kinetics, 2015.

PL254N NET GAMES - 2 (0-0-2) 1

[Shuttle & Ball Badminton/Volleyball/Lawn Tennis etc.]

Badminton: Revision of Fundamental Skills – Review of grips, footwork, serves, strokes, movement patterns, and correction of technical errors. Advanced Physical Conditioning – Speed, agility, endurance, plyometric exercises, reaction drills, and badminton-specific conditioning. Advanced Service and Return – Flick serve, deceptive serve, service variations, return of serve, and service strategies. Advanced Stroke Development – Jump smash, sliced drop, attacking clear, defensive clear, push shot, and backhand variations. Net Play and Defensive Skills – Net kill, spinning net shot, defensive block, defensive lift, and counter-attack techniques. Movement and Recovery – Multi-directional footwork, recovery speed, anticipation drills, and court coverage under pressure. Singles Strategies – Shot selection, rally construction, attacking and defensive play, deception, and tactical decision-making. Doubles Strategies – Front-back formation, side-by-side defence, rotation, communication, and attacking combinations. Game Analysis and Tactical Play – Match analysis, identifying strengths and weaknesses, strategy adaptation, and situational play. Officiating and Match Procedures – Umpire duties, line judging, scoring procedures, service faults, referee signals, and tournament rules. Competitive Match Practice – Structured singles and doubles match, performance evaluation, tactical feedback, and fitness reassessment. Intermediate Skill Assessment – Evaluation of technical skills, tactical understanding, match performance, officiating knowledge, and sportsmanship.

Prasad, R. (2010). Skills and Tactics in Badminton. Khel Sahitya Kendra, New Delhi, India.

Yadav, S. K. (2014). Modern Trends in Badminton. Friends Publications (India), New Delhi.

Grice, T. (2008). Badminton: Steps to Success (2nd Edition). Human Kinetics, Champaign, Illinois, USA.

Ball Badminton: Advanced serving techniques; Introduction to the Smash stroke (Forehand) with proper jump timing; Defensive blocking against smashes and fast-paced returns; Cross-court clearing and driving techniques to exploit open space; Intermediate Net Play; Doubles rotation strategies: transitioning from attack to defense; Specialization training; Half-court singles matches; Anticipation drills and reading the opponent's racket angle; Interval training and plyometrics for explosive court movement; Simulated tournament play with standard 29-point game structures.

Ball Badminton: A Complete Reference to India's Indigenous Racket Sport

Ball Badminton an Indian Racket Game: A Complete Guide to Its History, Rules, and Mastering Techniques

Official Rule Book and Guide to Ball Badminton (Ball Badminton Federation of India / Academic Institutional Manuals)

Volleyball: Improving fundamental skills and developing intermediate-level playing techniques. Students will receive practical training in overhand serving, setting, attacking approach, spiking, blocking, digging, service reception, defensive movements, and combination drills. The syllabus includes basic offensive and defensive formations, communication between players, positional play, transition from defence to attack, and team coordination. Regular practice matches and game situations will be conducted to improve physical fitness, skill execution, decision-making, teamwork, and understanding of tactical play.

FIVB, Official Volleyball Rules, Fédération Internationale de Volleyball.

Cecile Reynaud, The Volleyball Coaching Bible, Human Kinetics.

American Volleyball Coaches Association, Volleyball Skills & Drills, Human Kinetics.

PL255N MARTIAL ARTS - 2 (0-0-2) 1

[Karate/Taekwondo etc.]

Karate: Introduction to a simple basic Karate form with direction changes, balance, posture and breathing; controlled punch and front-kick practice using focus mitts or kick pads; supervised practice of a simple self-defence release from a wrist hold; integration of form, pad work and safe partner practice with emphasis on timing, coordination and control.

Taekwondo: Controlled combination practice involving stance, stepping, blocks, punches, front kick and round kick; safe target-pad holding and low-intensity pad drills; non-contact partner-distance practice; introduction

and group practice of a simple form-like sequence using known stances, blocks and punches, with emphasis on rhythm, posture, balance and teamwork.

PL256N STRENGTH SPORTS - 2 (0-0-2) 1

[Weightlifting/Powerlifting/Yoga etc.]

Weightlifting: Periodization basics including mesocycles and microcycles; percentage-based training and load selection; snatch technique at moderate intensity; clean & jerk technique at moderate intensity; overhead stability and jerk-recovery drills; accessory work such as back squat and pulling strength; tempo and pause-lift variations; competition rules and referee signals; training-log maintenance and program adjustment; mock technical-judging and peer refereeing practice; block periodization for weightlifting; high-intensity snatch technique at 80%+ singles; high-intensity clean & jerk technique at 80%+ singles; competition-style warm-up protocol; peer-coaching covering loading, timing and cueing; accessory strength work such as squats and pulls at higher loads; max-effort testing; designing a four-week training block; technical fault troubleshooting under fatigue; mock competition simulation with three attempts per lift; video analysis of mock-meet performance.
Bompa, T.O. & Haff, G.G., "Periodization: Theory and Methodology of Training," Human Kinetics.
Everett, G., "Olympic Weightlifting: A Complete Guide for Athletes & Coaches."
International Weightlifting Federation, "Technical and Competition Rules."
Drechsler, A., "The Weightlifting Encyclopedia."
Powerlifting: Activity introduces students to loaded lifts, allowing them to perform the three competition lifts with light loads for the first time. Training begins with the empty-bar squat, bench press and deadlift to consolidate technique under real barbell conditions. Students learn proper grip techniques, rack setup and adjustment, and safe plate-loading and unloading procedures. Breathing and bracing technique is introduced alongside core-strengthening exercises and the farmer's walk with a light load.
International Powerlifting Federation (IPF) Technical Rules Handbook, Latest Edition.
NSCA-Essentials of Strength Training and Conditioning, Latest Edition, Human Kinetics.
ACSM's Guidelines for Exercise Testing and Prescription
Introduction to Exercise Physiology & Sports Performance – IIT Madras
Yoga: Classical Hatha Yoga Practices-Surya Shakti Refinement. Surya Kriya, Yogasanas basics. Meditations. Invocation, related videos. Upa Yoga practices. Main Hatha Yoga practice. Meditation / Relaxation. Questions, reflections and sharing

PL257N WATER SPORTS - 2 (0-0-2) 1

[Swimming]

Swimming: Orientation & Baseline Assessment: Diagnostic 100m time trials, stroke rate evaluation, and target interval setting. Freestyle & Backstroke Refinement: Distance Per Stroke (DPS), catching water at full extension, and reducing drag. Flip-Turn Technique: Speed of approach, core rotation, wall contact power, and tight body tuck. Breaststroke & Butterfly Refinement: Energy conservation, timing fine-tuning, and high-elbow catch mechanics. Open Turns & IM Transition Mastery: High-speed approach, push-off trajectory, and legal transition turns for all 4 strokes. Interval-Based Conditioning: Aerobic base building using Work-to-Rest ratios and clock reading/send-off pacing. Interval-Based Conditioning: Threshold training, maintaining stroke integrity under fatigue, and heart rate monitoring. Pacing & Race-Pace Endurance: Even pacing vs. negative splitting strategies over 100m/200m distances. Pacing & Race-Pace Endurance: Target race-pace sets, stroke count control, and energy distribution strategies. Practical Demonstration & Peer Review: Student demonstration of refined flip-turns, breakouts, and race-pace interval sets.

PL258N INDIGENOUS SPORTS - 2 (0-0-2) 1

[Kabaddi/Kho-Kho/NSS etc]

Kabaddi: Competitive Fitness – High-intensity conditioning, recovery planning and performance monitoring. Match Planning – Opponent analysis, team selection, role allocation and pre-match strategy. Advanced Raid Sequencing – Raider rotation, tactical combinations and scoring management. Advanced Defence Systems – Corner-cover strategy, chain defence, trapping and coordinated pressure. Score and Time Management – Lead protection, comeback strategy and late-match decisions. Do-or-Die and Super-Tackle Strategy – High-pressure tactical scenarios and risk management. Leadership and Communication – Captaincy, on-court communication, motivation and conflict management. Officiating I – Court preparation, scoring, referee signals, raid/defence decisions and basic records. Officiating II – Fouls, technical situations, substitutions, time-outs and match documentation. Tournament Management – Fixtures, team registration, scheduling, scoring sheets and event coordination. Competitive Tournament – Inter-group league/knockout competition with formal performance review. Leadership Assessment – Match leadership, officiating, tournament role and comprehensive skill assessment.
Kho-Kho: Efficiency and control in the chasing; Improving defending skills; Introduction to intermediate techniques such as delayed Kho, fake Kho, chain Kho, cross-lane movement, pole turn, pole dive, controlled dive, zigzag running, and defensive feints. Basic biomechanics and exercise science are applied to improve acceleration, agility, reaction speed, balance, movement economy, and recovery. Tactical concepts include anticipation, space control, formation of pursuit angles, trapping, batch selection, communication, and time management. Structured drills and conditioned matches provide opportunities to apply individual skills within team situations. Emphasis on physical conditioning, injury prevention, fair play, peer observation, and basic officiating.
How to Learn Kho-Kho, by M.S. Tyagi, Dr. Shubhra Kathuria, and Sheetal Chauhan
KHO KHO FROM MUD TO MAT, by Man Singh, Ashwani R and Anil Lumar
NSS: Introduction to environmental issues and waste management, Climate change awareness activity, Waste segregation and recycling programme, Digital India awareness session, Skill India Mission programme activity, Jal Jeevan Mission awareness campaign, Rakshin Level IV training programme, Entrepreneurship survey and youth awareness programme, Road safety drive and awareness rally, Participation in institute activities, Community interaction and reporting activity, Two-day NSS special tour and activity evaluation.

PL259N NCC – PHYSICAL ACTIVITIES - 4 (0-0-2) 1

Advanced stamina conditioning; 5 km timed run and heavy interval sprints. Stress Management & Mental Wellness. Hydration, sports nutrition, and load recovery protocols. Advanced Yoga: Bakasana (Arm Balance), Sarvangasana (Shoulder Stand), Ustrasana, and extended meditation drills. Specialized Sport Mastery: Inter-platoon league matches, refereeing rules, team captaincy duties. 7 km cross-country endurance run evaluation.

Directorate General NCC (DGNCC) - NCC Cadet's Handbook. R.K. Gupta - NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations

PL311N ATHLETICS - 3 (0-0-2) 1

[Running/Jumping/Throwing etc]

Running: Advanced speed endurance drills; tactical pacing adjustments for individual vs. pack running. Advanced track mathematics: Deriving standard lane width boundaries and measuring straightaway links. Stagger Calculations: Applying geometric equations to compute exact start locations for 200m and 400m loops: Track Marking Practices: Using string lines and triangulation methods to mark lines on-field. Laying out the complex multi-lane deceleration and passing break-line zones. The mechanics of competitive officiating: Duties of the Track Referee and Lane Umpires. The Chief Starter's role: Managing verbal cues, gun locations, and electronic false start equipment. Timekeeping engineering: Operating digital stopwatches and interpreting Photo-Finish image layers. Managing rule violations: Processing disqualifications, handling lane violations, and filing official protests. Performance logging: Structuring event grids, seeding race heats, and managing

timing logs. Practical Track Lab: Students set up and mark a multi-lane short sprint track. Performance Trial: Practical exam on track marking precision and a mock sprint officiating assessment.
Jumping: Core and spinal flexibility conditioning; back arching mat drills. Introduction to the rhythmic sequence of the Hop, Step, and Jump phases. Phase 1 (The Hop): Executing single-leg take-off and landing on the same foot smoothly. Phase 2 (The Step): Projecting forward momentum onto the opposite landing leg. Phase 3 (The Jump): Converting residual momentum into a standard long jump landing extension. Rhythmic coordination: Combining the entire Hop-Step-Jump progression down the runway. Jump Facility Engineering: Layout rules, length requirements, and drainage specifications for runways and sand pits. Structural layout setup: Positioning take-off boards and plasticine indicators for multi-distance flights. Jump measurement methods: Using steel tapes and zero-point markers correctly in the sand pit. Jump Event Officiating: Duties of the Jump Referee, checking board fouls, and raising indicators flags. Performance sheet logistics: Managing round orders, breaking distance ties, and logging data. Performance Trial: Full Triple Jump execution trial alongside a field measurement precision assessment.
Throwing: Standard grips, stances and beginner technique for Shot Put, Discus and Javelin; Shot Put practice with the 'push' technique and standing throws for distance; Discus grip and standing throw technique with release-timing drills; Javelin grip, carry position and basic run-up practice with a soft javelin or vortex; and Throwball rules, positioning, court play and rally practice.
IAAF/World Athletics Technical Manual — Throwing Events (Shot Put, Discus, Javelin, Hammer)
Bunn, J. W., Scientific Principles of Coaching, Prentice Hall
SAI (Sports Authority of India) Coaching Manual — Athletics: Throws

PL312N INDOOR GAMES - 3 (0-0-2) 1

[Chess/Carroms/Table Tennis etc.]

Chess: Season planning and selection. Individual training plan for the semester; understanding classical, rapid and blitz formats and rating systems; selection trials and formation of institute teams. FIDE Laws of Chess and arbiting basics. Touch-move and illegal moves, clock rules and time forfeit, correct claims for threefold repetition, the fifty-move rule and dead position; role and duties of an arbiter; recording and defaults. Pairings and event administration. Swiss and round-robin systems, tie-break methods, seeding, use of pairing software (Swiss-Manager / Vega), preparing start lists, results reporting and cross-tables. Preparation with databases. Building and maintaining repertoire files, searching model games, opponent-specific preparation, identifying an opponent's pet lines and choosing a practical surprise weapon. Advanced endgame technique. Complex rook endings, rook versus minor piece, queen versus pawn, multi-piece endings; practical conversion and defensive drills under clock pressure. Classical game and post-mortem discipline. A full-length classical game with complete notation, followed by structured post-mortem - classifying errors as calculation, evaluation, opening knowledge or time-related, and building a personal blunder-check routine. Competitive mindset and team chess. Concentration, handling nerves and time trouble, recovering after a loss, pre-game and rest routine; board order and match strategy, captaincy, team etiquette and communication. Tournament, mentoring and evaluation. Organising and playing in an intra-institute tournament; conducting a mentoring session for a junior batch; practical evaluation, viva-voce and presentation of the individual training plan.
Carroms: Performance Assessment; Advanced Match Strategy and Tactical Adaptation; High-Pressure Shot Execution and Decision-Making; Advanced Singles and Doubles Strategies; Evaluation & Assessment; Competition Rules, Scoring and Officiating; Tournament Organization and Scheduling; Leadership, Teamwork and Sportsmanship; Mock Tournament: Singles and Doubles Matches, Officiating, Tactical Play and Pressure Management.
Table Tennis: Theory and practical explanation and demonstration of the concept of spin, advance backhand and pendulum serves and their receiving techniques, advance tomahawk and lollypop serves and their receiving techniques, first five balls — what are they, their importance, and drills on the first, third and fifth balls, drills on the second and fourth balls and creation of the point with a combination of the first five balls, introduction to long pimple and half long pimple rubbers and technique to play against them, introduction to short pimple and anti-spin rubbers and technique to play against them, ways to play against an attacking player

and against an all-round attacker, ways to play against a defensive player/chopper; matches against players using different rubbers as an experience, rules and regulations of umpiring, responsibilities of the umpire and match conduction, tournament planning — categories, venue, marketing, budgeting, permissions, draw, seeding, fixtures, score sheets and registrations, tournament organisation and video analysis of match play.

PL313N FIELD GAMES - 3 (0-0-2) 1

[Cricket/Football/Basketball etc.]

Cricket: Cricket coaching principles; Lesson plan preparation; Skill testing and performance evaluation; Talent identification and player development; Training cycles and periodization; Laws of cricket and umpiring; Scoring and match statistics; Tournament planning and event management; Ground preparation and pitch maintenance; Leadership and team management.

Basics of Cricket; Dr.R. Ram Mohan Singh; BlueRose Publishers Pvt. Ltd.;2024.

Marylebone Cricket Club (MCC); The Laws of Cricket; London: Marylebone Cricket Club; 2017 Code (3rd Edition – 2022).

Football: Offensive Heading: Direct attacking headers aimed downwards or toward target corners to score. Clearance Heading: Defensive heading and high-clearance headers aimed up, out, and away from danger areas. Advanced Goalkeeping Stance: Goalkeeper structural stance, footwork, lateral shifting, and proactive positioning relative to the ball vector. Advanced Collection: High-pressure ball collection techniques under aerial challenge. Advanced Distribution Systems: Goalkeeper counter-attacking distribution methods. Sub-Group Tactics: 1 vs 1 and 2 vs 2 Attacking and Defending situations. Group Systems: 3 vs 3 tactical setups studying small triangles, overlapping patterns, and space squeeze mechanisms. Extended Group Systems: 4 vs 4 systems evaluating spatial distribution, defensive containment lines, and breaking the press. Introduction to Small-Sided Games (SSG): SSG structural concepts (overloads, transition phases, and possession maintenance drills). SSG Tactical Variation: Conditioned SSGs - restricted touches, mandatory wide passes, fast-break counters. End-Semester Practical Evaluation.

The International Football Association Board (IFAB). Laws of the Game. Official Annual Rulebook

Luxbacher, J. A. (2014). Soccer: Steps to Success. Human Kinetics.

Coyle, D. (2009). The Talent Code: Greatness Isn't Born. It's Grown. Here's How. Bantam Books.

Basketball: Rules revision, Refereeing signals, Scorekeeping, Tournament planning, Captain responsibilities, Leadership drills, Competitive practice, Match officiating, Team strategy, Tournament rounds, Finals, Performance review

Han Wissel, Basketball: Steps to Success (3rd ed.), Human Kinetics, Champaign, Illinois, 2011.

Jerry V. Krause & Don Meyer, Basketball Skills & Drills (3rd ed.), Human Kinetics, 2008.

PL314N NET GAMES - 3 (0-0-2) 1

[Badminton/ Ball Badminton/Volleyball etc.]

Badminton: Elite Physical Conditioning – High-intensity interval training, explosive movement, endurance, agility, reaction speed, injury prevention, and recovery techniques. Advanced Stroke Precision – Jump smash variations, deceptive strokes, cross-court attacks, spinning net play, and precision placement drills. Advanced Tactical Play – Rally planning, opponent analysis, attacking patterns, defensive transitions, and tactical adaptability Singles Performance Training – Match planning, pressure situations, point construction, mental focus, and advanced court management. Advanced Doubles Performance – Mixed doubles strategy, rotational systems, communication, synchronized attack and defence, and transition play. Performance Analysis – Video analysis, error identification, tactical review, self-assessment, and corrective training. Leadership and Team Management – Team leadership, communication, mentoring, conflict resolution, sports ethics, and event organization. Coaching Fundamentals – Planning practice sessions, demonstration techniques, skill correction, player feedback, and coaching methodology. Tournament Organization and Officiating – Tournament planning, fixture preparation, officiating responsibilities, referee decisions, and code of conduct. Competitive Tournament Play – League and knockout format matches, performance evaluation, tactical

execution, and fitness assessment. Final Skill Assessment and Championship – Comprehensive practical assessment through tournament participation, evaluation of technical proficiency, tactical awareness, officiating ability, leadership, teamwork, and sportsmanship.

Cabello Manrique, D., & González-Badillo, J. J. Badminton. ITF Sports Science Publications.
Badminton World Federation. BWF Statutes – Laws of Badminton.
Cabello Manrique, D., & González-Badillo, J. J. Badminton. ITF Sports Science Publications.

Ball Badminton: Advanced tactical video analysis; Deceptive strokes; Backhand Smash and high-pressure returns; Target-based attacking drills; Counter-attacking strategies from defensive positions; Sports nutrition, hydration, and injury prevention; Introduction to officiating: Rules for the Chief Referee, Line Judges, and Scorer; Practical officiating practice; Mental conditioning, managing match anxiety, and tactical communication; Designing personalized training regimens and warm-up routines.

Ball Badminton: A Complete Reference to India's Indigenous Racket Sport
Ball Badminton an Indian Racket Game: A Complete Guide to Its History, Rules, and Mastering Techniques
Official Rule Book and Guide to Ball Badminton (Ball Badminton Federation of India / Academic Institutional Manuals)

Volleyball: Advanced skills, tactical understanding, competitive match play, and officiating. Students will develop advanced techniques in serving, receiving, setting, attacking, blocking, digging, defensive systems, and coordinated team play. The course covers offensive and defensive strategies, attack combinations, blocking systems, service-receive formations, transition play, player positioning, match preparation, and game analysis. Students will participate in competitive matches, practical assessments, scoring, basic refereeing, and application of official volleyball rules, with emphasis on leadership, discipline, sportsmanship, fitness, and effective team performance.

FIVB, Official Volleyball Rules, Fédération Internationale de Volleyball.
Donald C. Shondell and Cecile Reynaud, The Volleyball Handbook, Human Kinetics.
Cecile Reynaud, The Volleyball Coaching Bible, Human Kinetics.
American Volleyball Coaches Association, Volleyball Skills & Drills, Human Kinetics.

PL315N MARTIAL ARTS - 3 (0-0-2) 1

[Lathi/Kalari/Karate/Taekwondo etc.]

Karate: Consolidation of earlier Karate practice through fitness review, flexibility, balance, coordination and stamina; revision of basic form and controlled pad practice; pre-arranged non-contact partner drills, safety and injury-reporting practices, group formation and preparation of a disciplined final demonstration.

Taekwondo: Consolidation of Taekwondo fundamentals through fitness revision, balance, flexibility and controlled breathing; revision of stances, stepping, guard position, blocks, punches, front kick and round kick; controlled combination practice, soft target-pad work, group preparation and non-contact practical demonstration with emphasis on discipline, teamwork and safety.

PL316N STRENGTH SPORTS - 3 (0-0-2) 1

[Weightlifting/Powerlifting/Yoga etc.]

Weightlifting: Peaking principles including volume reduction and intensity progression; snatch technique refinement at near-maximal loads; clean & jerk technique refinement at near-maximal loads; meet-day protocol covering weigh-in and attempt cards; warm-up room simulation and timing; attempt-selection strategy; mock officiating and referee-signal practice; full mock competition with three attempts per lift; video review and individual feedback; injury-prevention review.

International Weightlifting Federation, "Technical and Competition Rules."
Everett, G., "Olympic Weightlifting: A Complete Guide for Athletes & Coaches."
Bompa, T.O. & Haff, G.G., "Periodization: Theory and Methodology of Training," Human Kinetics.

Powerlifting: Activities focus on developing student confidence in the three competition lifts using prescribed training loads. Students perform the back squat, bench press and conventional deadlift with progressively

increasing loads, supported by squat-depth assessment, bench-press commands and deadlift lock-out practice. Spotting during the bench press is introduced as loads increase, along with accessory lower-body exercises and recovery techniques to support training adaptation.

International Powerlifting Federation (IPF) Technical Rules Handbook, Latest Edition.

NSCA-Essentials of Strength Training and Conditioning, Latest Edition, Human Kinetics.

ACSM's Guidelines for Exercise Testing and Prescription

Introduction to Exercise Physiology & Sports Performance – IIT Madras

Yoga: Classical Hatha Yoga Practices-Complete Yogasana sequence. Surya Kriya refinement. Angamardana refinement. Meditations. Invocation, related videos. Upa Yoga practices. Main Hatha Yoga practice. Meditation / Relaxation. Questions, reflections and sharing

PL317N WATER SPORTS - 3 (0-0-2) 1

[Swimming]

Swimming: Orientation & Sprint Power Mechanics: Anaerobic power generation, reaction time, explosive force off the block, and velocity profiling. Advanced Sprint Technique: High-cadence stroke cycles, pitch control, maintaining mechanical efficiency at maximum velocity, and breath-holding strategy. Advanced Starts, Breakouts & Relay Exchanges: Track start reaction drills, backstroke ledge starts, underwater kick power, and relay exchange timing. Slalom & Directional Agility Drills: Water navigation, buoy turn mechanics, slalom maneuvering drills, and maintaining velocity during directional changes. Race-Line Strategy (Part 1): Lane positioning, holding strict race-lines, wave-draft mitigation, and clean wall entry/exit trajectories. Race-Line Strategy (Part 2): Tactical pacing models, split-time management, aggressive breakout mechanics, and head-to-head race tactics. World Aquatics Competition Rules (Part 1): Official stroke legality rules, turning requirements, touch-finish protocols, and avoiding disqualifications (DQs). World Aquatics Competition Rules (Part 2): Relay rules, false start policies, call room procedures, lane seedings, and official technical judge roles. Pre-Race Preparation & Tapering: Competition warm-up protocols, activation routines, race-day nutritional timing, and mental focus strategies. Mock Race (Finals & Relays): Championship sprint finals, 4x50m relay competition, race-line tactical execution, and competitive pressure management.

PL318N INDIGENOUS SPORTS - 3 (0-0-2) 1

[Kabaddi/Kho-Kho/NSS etc.]

Kabaddi: Performance Benchmarking – Advanced fitness testing, skill profiling and individual performance targets. High-Performance Conditioning – Speed, power, agility, endurance, mobility and recovery planning. Advanced Raid Design – Individual raiding style, combination planning, opponent analysis and execution. Advanced Defensive Systems – Tactical traps, coordinated pressure, chain systems and counter-strategies. Match Analytics – Performance indicators, raid/defence statistics, video review and tactical reporting. Peer Coaching I – Demonstration, correction and safe teaching of fundamental and intermediate skills. Peer Coaching II – Designing drills, giving feedback and managing small practice groups. Advanced Officiating – Referee responsibilities, scoring, match control, technical situations and records. Tournament Leadership – Fixtures, scheduling, team management, venue readiness and event coordination. Competitive Tournament – Student-led league/knockout competition and performance documentation. Final Performance Review – Individual/team analysis, fitness reassessment and improvement planning. Capstone Assessment – Competitive match, peer coaching, officiating/tournament role and reflective review.

Kho-Kho: Integrated application of advanced Kho-Kho skills in competitive and performance-oriented situations. Refine chasing techniques, defensive combinations, diving actions, pole skills, tactical planning, and rapid decision-making under match pressure. Understanding on biomechanics, physiology, performance analysis, nutrition, recovery, and injury-prevention principles. Examining opponent behaviour, batch composition, substitution decisions, score and time situations, and alternative tactical plans. Match organization, peer coaching, leadership, and the ethical management of competition. Conducting structured

matches or a tournament to assess technical competence, tactical awareness, teamwork, leadership, and sportsmanship.

How to Learn Kho-Kho, by M.S. Tyagi, Dr. Shubhra Kathuria, and Sheetal Chauhan

KHO KHO FROM MUD TO MAT, by Man Singh, Ashwani R and Anil Lumar

NSS: Health and hygiene awareness session, Nutrition and healthy lifestyle program, Drug abuse prevention awareness campaign, First aid and emergency response training, Disaster preparedness activity, Atmanirbhar Bharat Abhiyan awareness program/Independence Day parade participation, Rakshin Level–V training program, Road safety drive, Plastic-free campaign, Village adoption and health awareness programme, Participation in government and institute activities, NSS special tour and activity documentation.

PL319N NCC – PHYSICAL ACTIVITIES - 5 (0-0-2) 1

Peak physical conditioning; 8 km speed march/run with light kit. Mental Wellness & Resilience. Breath-control under stress, cadet peer counselling, advanced practical Yoga flow. Specialized Sport Championship: Final inter-troop/institute tournament. Final preparation and pacing strategy for long-distance endurance running. 10 km Final Endurance Run Assessment.

Directorate General NCC (DGNCC) - NCC Cadet's Handbook. R.K. Gupta - NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations

Cultural Activities

PL120N INTRODUCTION TO CULTURAL ACTIVITIES - 1 (0-0-2) 1

Introduction to four cultural activities out of eight activities. Introduction to the remaining four activities is part of PL160N in the second semester.

Culinary Arts: Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc.
Dance: Bharatanatyam/Yakshagana/Fusion etc.: Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc.
Fashion Design: Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Film Making: Film making/Photography/Scripting/Animation etc- Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Literature & Stage: Dramatics/Sanskrit Literature/Poetry/Debating & Elocution etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Music: Carnatic/Hindustani/Instrumental etc -Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Painting: Painting & Sketching/Folk Art etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Sculpting: Clay Modelling/Craft & Toymaking etc. - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc

PL129N NCC-CULTURAL ACTIVITY - 1 (0-0-2) 1

Introduction to NCC marching band, origin, history, institutional role, evolution of military bands in India. Band instruments: sections, terminology, safe handling, assembly/disassembly, storage, hygiene, and maintenance, Underlying science of music. Instrument-specific demonstrations, basic technique workshops, ensemble basics, and guided practice.

Arnold Myers, Murray Campbell, Christophe Kausel, D. Sharp - The Science of Brass Instruments. Ray Westlake - A Guide to Military Art Bands, Bandsmen and Sheet Music Covers. Trevor Herbert, Helen Barlow - Music & the British Military in the Long Nineteenth Century.

PL160N INTRODUCTION TO CULTURAL ACTIVITIES - 2 (0-0-2) 1

Introduction to four cultural activities out of eight activities. Introduction to the remaining four activities is part of PL120N in the first semester.

Culinary Arts: Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc.
Dance: Bharatanatyam/Yakshagana/Fusion etc.: Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc.
Fashion Design: Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Film Making: Film making/Photography/Scripting/Animation etc- Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Literature & Stage: Dramatics/Sanskrit Literature/Poetry/Debating & Elocution etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc

Music: Carnatic/Hindustani/Instrumental etc -Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Painting: Painting & Sketching/Folk Art etc - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc
Sculpting: Clay Modelling/Craft & Toymaking etc. - Origin & History, Key personalities, Achievement, Underlying science, Tools (instruments) and Techniques, Best practices, Demo, Assignment, Evaluation, etc

PL169N NCC-CULTURAL ACTIVITY - 2 (0-0-2) 1

Reinforcement of band history, organization, terminology, and safe handling. Individual practice setup, rhythm fundamentals, instrument technique, band organization, and musical notation. Sectional practice including unison exercises, call-and-response, and tempo maintenance. Ensemble coordination: start/stop cues, counting-in, listening, balance, and discipline. Marching-band fundamentals and elementary band repertoire.

Arnold Myers, Murray Campbell, Christophe Kausel, D. Sharp - The Science of Brass Instruments. Ray Westlake - A Guide to Military Art Bands, Bandsmen and Sheet Music Covers. Trevor Herbert, Helen Barlow - Music & the British Military in the Long Nineteenth Century.

PL221N CULINARY ARTS – 1 (0-0-2) 1

Kitchen Basics & Everyday Cooking-Kitchen safety and hygiene, knife skills, basic tools and equipment, understanding ingredients and measurements. simple breakfast dishes (sandwiches, omelettes, poha, upma), basic rice and dal, one-pot meals, simple salads and dressings.

PL222N DANCE – 1 (0-0-2) 1

[Bharatanatyam/Yakshagana/Fusion etc.]

Bharatnatyam: Introduction to Bharatanatyam covering basic posture, Namaskaram, Araimandi, warm-up exercises and fundamental Adavus such as Tatta, Natta, Visharu, Tatti Mettu and Kuditta Mettu. Introduction to Tala, Laya, rhythm exercises, Korvais, Drishti, Griva, Shiro Bhedas and Asamyuta Hastas.
Yakshagana: Introduction to Yakshagana fundamentals, including Yeradane Hejje in different Kalagathis, basic Talas such as Eka, Roopaka and Triputa, and concepts of Biditha, Mukthaya and Kalagathi. Introduction to Kore, Jampe and Ashta Tala, along with basic Salamu Hejje and Yeru Padya Nade. Introduction to basic Pravesha techniques and an overview of Yakshagana makeup and stage practices
.
Fusion: Covers the fundamentals of Kathak, including theory, basic footwork, hand gestures, spins, rhythm and expressions. Bhangra through basic and advanced movements, followed by Gujarat Garba and Dandiya. Karnataka folk traditions, including Kamsale, Yakshagana and Veeragase, with emphasis on basic movements, cultural context and performance practice.

PL223N FASHION DESIGN – 1 (0-0-2) 1

Foundations of Fashion Design: Elements and principles of design, textile concepts, dyeing, printing, embroidery, sewing basics. Learn fundamental textile and fabric concepts. Introduction to Dyeing. Dyeing Techniques. Introduction to Printing. Printing Methods. Surface Embellishment and Embroidery. Basics of sewing.

PL224N FILM MAKING – 1 (0-0-2) 1

[Film making/Photography/Scripting/Animation etc]

Film Making: Introduction to visual storytelling, narrative structure, emotions, and visual language. Covers composition, lighting, colour, symbolism, observation, photo essays, film appreciation, storyboarding, and dialogue-free visual storytelling.

Photography: Learn the Camera- Photography as visual communication; camera types, controls, and file formats (JPEG/RAW). Exposure triangle — aperture, shutter speed, ISO — from auto to manual, with depth of field and motion blur. Metering modes, histogram reading, focal length, and focus technique. Composition fundamentals: rule of thirds, leading lines, framing, negative space, golden ratio, applied to campus/engineering subjects. White balance, color temperature, and semester critique.
Scripting: Recollections and reflections; three-act structure; scene purpose and design; sequence and progression; exposition without overload; pacing and tension; visual storytelling; writing transitions between scenes; scene expansion exercise; scene reduction exercise; presentation of student scripts; submission of a 3–5 scene mini-script.
Animation: 2D Animation Fundamentals- 2D animation workflow, digital tools, animation principles (squash and stretch, anticipation, timing, spacing), character design, expressions, poses, turnaround sheets, storyboarding, keyframes and in-betweens, walk cycle, background design, coloring and shading, frame-by-frame animation, editing, rendering/exporting, mini project presentation.

PL225N LITERATURE & STAGE – 1 (0-0-2) 1

[Dramatics/Sanskrit Literature/Poetry/Debating & Elocution etc]

Dramatics: (Physical Theatre, Improvisation, Voice & Emotion)- Orientation and trust-building, ensemble games, neutral body/posture, physical theatre and narrative through movement, rhythm/Yakshagana-inspired footwork, improvisation fundamentals ("Yes, and"), object work/mime, character and narrative improve, peer showcase → Vocal anatomy and breath, projection/resonance, articulation, sound-impulse connection, Natyashastra's Bhava-Rasa framework, the Navarasas (Shringara, Hasya, Karuna, Raudra, Veera, Bhayanaka, Bibhatsa, Adbhuta, Shanta), vocal-emotional layering, choral speech, micro-scene workshop, final vocal-emotional assessment.
Sanskrit Literature: The syllabus covers Sanskrit basics and communication, including self-introduction, nouns, pronouns, verbs, adjectives, cases, infinitives, question formation, sentence structure, numbers, time, routines, conjunctions, and conversational practice. It also introduces Chhandas, sentence correction, Subhashitanis and Neeti Shlokas, along with selected Sanskrit literature, Panchatantra and Hitopadesha stories, biographies, Indian history, dramas, Ramayana, Mahabharata, Abhijnana Shakuntalam, Raghuvamsha, and Shukanasa Upadesha.
Poetry: Poetry and the self: observation, memory, metaphor, resilience and identity. Students apply the first-year foundations to personal expression through campus observation, sensory writing, free verse, haiku, home and memory poems, emotional vocabulary, engineering metaphors, failure and resilience writing, values reflection and revision. The semester treats poem-making as a process similar to design iteration: draft, test with peers, revise and reflect. Activities include Where I Come From poems, I Am poems using technical images, A Letter to My Failed Attempt, time-use poems, values poems, voice practice and an Engineering Self portfolio with revision notes and reflective commentary.
Debating & Elocution: Foundations of public speaking, three Vs of communication, body language, posture, gestures, facial expressions, eye contact, stage space, voice and delivery, breath control, pitch modulation, pacing, articulation, stage fright, vocabulary, grammar, syntax, phonetics, speech structure, openings, conclusions, verbal crutches, clichés, redundancies, mother-tongue interference.

PL226N MUSIC -1 (0-0-2) 1

[Carnatic/Hindustani/Instrumental etc]

Carnatic: Foundations of Carnatic Music- Revision and listening sessions, shruti alignment, swaras (Sa–Ni), Sarali Varisai (1–14), Jantai Varisai, Dhatu Varisai, Geetham I and II, group stage performance.
Hindustani: (Ragas, Talas & Chota Khayal I): Theory of ragas and talas, alankaras, aroha-avaroha of ragas, Chota Khayal (Bhoop, Durga, Desh, Bageshri, Khamaj, Kafi), Vande Mataram, revision with shruti and tala.
Instrumental: Keyboard/Piano — Chords & Accompaniment: Revision of scales, chords, and notation, finger independence, major triads (C, F, G, D, A, E), minor triads (A, D, E and others), chord progressions (I–IV–V,

I–V–vi–IV), chord inversions, left-hand accompaniment (block chords, broken chords, arpeggios, bass notes), rhythm patterns (4/4, 3/4, 6/8), melody-chord coordination, scales with accidentals, introduction to arpeggios, song arrangement, and individual/group performance.

PL227N PAINTING – 1 (0-0-2) 1

[Painting & Sketching/Folk Art etc]

Painting & Sketching: (Pencil Drawing & Portraiture): Tool selection, line control, hand-eye coordination, shapes, proportion, perspective, light and shadow, facial proportions, facial features (eyes, eyebrows, nose, lips, ears, hair), hand anatomy, realistic portraits (front, profile, three-quarter), cartooning and exaggeration, expressions, body movements, character design.
Folk Art: The syllabus introduces Indian folk and tribal art traditions through the study of Madhubani, Gond, Warli, Pithora, and Mata Ni Pachedi. Key areas include historical and cultural context, community traditions, mythology, nature, rituals, symbolism, motifs, geometric forms, line, dots, patterns, and traditional colours. Practical work focuses on line and pattern exercises, motif studies, borders, human and animal forms, narrative compositions, and creating inspired artworks on paper, canvas, or wall surfaces.

PL228N SCULPTING – 1 (0-0-2) 1

[Clay Modelling/Craft & Toymaking etc.]

Clay Modelling: The syllabus introduces clay properties, preparation, tools, safety, hand-building, modelling, pottery wheel basics, drying and firing. Practical work includes pinching, coiling, slab building, joining, shaping, texturing, basic wheel-thrown forms, and simple functional or sculptural pieces.
Craft & Toymaking: Scratch art, mosaic art, greeting cards and paper doily craft, Raksha Bandhan activity, bookmarks, CD-based candle holder craft, kirigami, dhurrie rugs, shirt-style greeting cards, radial paper relief sculpture, Deepavali kundan work, waste-to-worth building models, and notan art with zentangle.

PL229N NCC-CULTURAL ACTIVITY - 3 (0-0-2) 1

Advanced Instrumental Technique & Tuning, Scale Mastery & Sight-Reading, Stationary Drill & Instrument Handling, Sectional Harmony & Balance, Marching Fundamentals (Tez Chal), Elementary Parade Repertoire.

Arnold Myers, Murray Campbell, Christophe Kausel, D. Sharp - The Science of Brass Instruments.
Ray Westlake - A Guide to Military Art Bands, Bandsmen and Sheet Music Covers.
Trevor Herbert, Helen Barlow - Music & the British Military in the Long Nineteenth Century.

PL261N CULINARY ARTS – 2 (0-0-2) 1

Indian Regional Cuisine- Regional classification of Indian food, basic masala and gravy bases, tandoor-style vegetarian basics (paneer tikka), Punjabi vegetable curries, vegetable biryani, Rajasthani dal baati, Gujarati kadhi, South Indian classics (dosa-sambar, bisi bele bath), Kerala vegetable stew with appam, Indian breads (naan, kulcha), and a mini regional-thali cook-off.

PL262N DANCE – 2 (0-0-2) 1

[Bharatanatyam/Yakshagana/Fusion etc.]

Bharatnatyam: Basics of Nritta, Nritya, Natya, Navarasa and Abhinaya through simple storytelling and expressive movements. Short Expressive Dance (Devaranama/Bhajan). Introduction to costume, jewellery, makeup and stage aesthetics.
Yakshagana: Advanced practice of Talas, Hejje and Pravesha, including Yeru Pravesha, Ola Pravesha and different Pravesha patterns based on Tala. Introduction to Aadi Tala and its variations, Digina/Laga, and Bhairavi Ashta Namoonevaar in Yeru Pravesha. Practical training in makeup for Pundu and Stri Vesha, along with Pravesha techniques for different characters and stage situations.

Fusion: Introduces Hip-Hop theory and practical techniques, progressing from basic movements and footwork to advanced combinations. Contemporary Dance, including basic techniques, floor work, body flow and advanced movements. Freestyle techniques, covering improvisation, basic freestyle vocabulary and advanced freestyle performance skills.

PL263N FASHION DESIGN – 2 (0-0-2) 1

Fashion Design Process & Explorations Design process, design boards, range development, flats drawing, pattern making. Introduction to design thinking, Design Boards (Adobe Photoshop). Range Development, Flats Drawing (Digital), Pattern Making: Introduction to drafting patterns from sketches, Developing garment blocks and variations, Refinement, fitting adjustments, and preparing for construction.

PL264N FILM MAKING – 2 (0-0-2) 1

[Film making/Photography/Scripting/Animation etc]

Film Making: Film Production- Introduction to film production, direction, production planning, equipment, lighting, camera and sound. Students undertake short-film production, including principal photography, B-roll, footage management, documentation, presentation, and screening.
Photography: Learn Light. Natural light: quality, direction, golden/blue hour, managing harsh light with diffusion. Artificial light basics: continuous LED vs. flash, safe single-light setup. Portrait essentials: 3-point lighting concept, posing, environmental portraiture. Product/object photography for engineering: prototypes, lab equipment, reflection/shadow control, basic macro. Architecture and infrastructure photography; semester critique.
Scripting: Review of scene writing; voice and character individuality, dialogue as action; subtext in conversation; conflict in dialogue; monologue and self-talk (soliloquy); writing for emotional moments; gesture, silence, and pauses; character-driven scenes; editing weak dialogue; table read and feedback; submission of a dialogue-heavy scene; group presentations.
Animation: Advanced 2D Animation & Motion- Advanced motion principles, camera movements, scene transitions, lip synchronization, facial animation, audio integration, advanced character animation, special effects, particle animation, scene composition, cinematography, timing polish, multi-scene animation, editing and enhancement.

PL265N LITERATURE & STAGE – 2 (0-0-2) 1

[Dramatics/Sanskrit Literature/Poetry/Debating & Elocution etc]

Dramatics: (Text Analysis & Playwriting)- Reading a script like an artist, given circumstances, scene anatomy and conflict, objectives/obstacles, subtext, dramatic beats, table readings (clarity, then atmosphere via voice/Rasa), comparative text study (classical Indian, Western realist, contemporary), dramatic reading lab, peer critique, final dramatic reading showcase, Playwriting basics, observational writing, character design, dialogue writing, script formatting, monologue writing, short play structure, group writing lab, cold readings, editing, final playwriting portfolio.
Sanskrit Literature: Ancient Art, Science and Technological Advancement: Selected excerpts from Shiksha, Vyakarana Shastram (Ashtadhyayi, Siddhanta Kaumudi), Shulba Sutram, Siddhanta Jyotisham (Aryabhatta, Bhaskara), Kerala Ganita Vicharadhara, Rasa Shastram, Dhanurvedam, Ayurvedam, Bharadvaja Natya Shastram, Shilpa Shastram, Kautilya Arthashastram, Dharma Shastram, and Parishilanam.
Poetry: Poetry and others: empathy, listening, inclusive communication, spoken word and collaboration. Students move from self-expression to perspective-taking through persona poems, dialogue poems, multilingual group poems, poems on friendship, conflict, dignity, belonging, access and design empathy. Spoken-word practice introduces breath, pause, clarity, rhythm, repetition, storytelling, audience awareness and stage discipline. Group work focuses on role allocation, rehearsal discipline, respectful disagreement and feedback quality. The semester culminates in an empathy/performance portfolio and an individual or group spoken-word presentation connected to campus life, teamwork, inclusion, technology or mental well-being.

Debating & Elocution: Rhetorical devices, ethos, pathos, logos, metaphor, anaphora, rule of three, manuscript and memorized speaking, historical speech recitation, argumentation, claim-data-warrant-impact, evidence gathering, information literacy, logical fallacies, strawman, ad hominem, slippery slope, confirmation bias, team debating, cross-examination, parliamentary debate, 8-player debate structure, flow-sheeting, active listening.

PL266N MUSIC -2 (0-0-2) 1

[Carnatic/Hindustani/Instrumental etc]

Carnatic: (Alankaras & Early Compositions): Alankaras, Geetham III, introduction to raga, introduction to tala system, listening session (identifying swaras in simple songs), simple song/bhajan, Swarajati I, group stage performance, individual performances.
Hindustani: (Ragas, Talas & Chota Khayal II) Theory of ragas and talas, alankaras, aroha-avaroha of ragas, Chota Khayal (Yaman, Bhairav, Bhairavi, Bhimpalasi, Bihag, Jaunpuri), Dhrupad (Bhimpalasi), Tarana (Bihag), revision with shruti and tala.
Instrumental: Keyboard/Piano — Chords, Progressions & Arrangement: Scale and chord revision, seventh chords (major 7th, minor 7th, dominant 7th, chord resolution), extended chords (6th, suspended, added-note), advanced progressions (ii–V–I, I–vi–IV–V), arpeggio techniques, rhythm and groove (pop, rock, waltz, ballad, 6/8), accompaniment styles (chordal, bass-chord, Alberti patterns), transposition and key changes, introduction to improvisation, and full song arrangement (intro, verse, chorus, bridge, ending).

PL267N PAINTING – 2 (0-0-2) 1

[Painting & Sketching/Folk Art etc]

Painting & Sketching: (Colour Pencil Techniques)- Colour theory, core colour pencil techniques, layering and blending, burnishing, fruit studies (spherical forms, textures), floral petal mapping and colour transitions, bird anatomy and feather textures, beak/eye rendering, food illustration, shiny vs. matte object rendering, still life composition.
Folk Art: The syllabus explores regional Indian folk-art traditions through Hase Chittara, Advanced Kaavi Art, Manjusha, Tikuli, and Bengal Patachitra, Chitrakathi, Santal painting focusing on cultural context, rituals, symbolism, geometric and floral motifs, line, pattern, symmetry, ornamentation, and narrative storytelling. Practical work includes geometric and fine-line exercises, motif and border development, floral and narrative compositions, panel design, architectural applications, and traditional-art-inspired artworks or murals.

PL268N SCULPTING – 2 (0-0-2) 1

Clay Modelling: The syllabus focuses on advanced hand-building, functional pottery, wheel throwing, trimming, finishing, drying, firing, and common defects. Practical work includes functional hand-built pottery, wheel-thrown bowls or vessels, and an additional piece combining learned techniques.

Craft & Toymaking: African Kente paper weaving, batik art, cityscape art, tissue texture coasters, stencil bottle art, pista-shell candle holders, candle making, flower garland making, crepe-paper shirt with hanger, greeting cards, name board craft, and notan art with zentangle.

PL269N NCC-CULTURAL ACTIVITY - 4 (0-0-2) 1

Advanced Drum Major Commands & Signals, Intermediate Marching Band Repertoire, Counter-Marching & Column Turns, Field Formations & Interval Maintenance, High-Intensity Full Parade Rehearsals, Independence Day Live Readiness & Practical assessment.

Arnold Myers, Murray Campbell, Christophe Kausel, D. Sharp - The Science of Brass Instruments. Ray Westlake - A Guide to Military Art Bands, Bandsmen and Sheet Music Covers. Trevor Herbert, Helen Barlow - Music & the British Military in the Long Nineteenth Century.

PL321N CULINARY ARTS – 3 (0-0-2) 1

Continental & International Cuisine - Basic vegetable soups and consommé, mother sauces (béchamel, tomato), simple pasta (Alfredo, Arrabbiata), risotto basics, grilled vegetables and gratins, vegetable steaks with sauces, intro to French and Italian dishes (vegetable lasagna), Mediterranean mezze platter, basic plating, and a simple three-course vegetarian meal challenge.

PL322N DANCE – 3 (0-0-2) 1

Bharatnatyam: Short group Nritta sequences and a devotional dance (Devaranama/Bhajan), followed by basic choreography, group synchronization, stage movement, costume and stage aesthetics, rehearsal and performance.

Yakshagana: Advanced Yakshagana performance training through Kireeta and Bannada Vesha, Sabha and Their classes. Practice of Tala-based movements, Pravesha and Salamu Hejje with musical accompaniment. Introduction to and practice of Yakshagana Roopaka, including selection and enactment of stories from the Ramayana or Mahabharata, integrating movement, rhythm, characterisation, makeup and stage performance.
Fusion: Dance Composition Principles, advanced footwork, Abhinaya and musicality, followed by practical training in solo, duet and group choreography. Integrate different dance forms, develop complete choreographies and participate in complete dance production practice, including coordination, staging and performance presentation.

PL323N FASHION DESIGN – 3 (0-0-2) 1

Review of Pattern Making, Finalisation of Patterns, Garment Construction - Cutting, stitching, fitting, Finishing. Portfolio Development, Rehearsal and peer feedback, Final showcase and portfolio presentation.

PL324N FILM MAKING – 3 (0-0-2) 1

Film Making: Post-Production- Introduction to editing and post-production workflows. Covers editing, pacing, sound, colour grading, titles, motion graphics, and basic visual effects. Students complete editing, review, refinement, final submission, and screening.

Photography: Learn Editing. File management: RAW vs. JPEG, bit depth, archiving, editing app orientation (Snapseed/Darktable/GIMP). Global tonal adjustment: histogram, exposure, tone curve. Color correction, white balance fixes, HSL adjustment, basic color grading. Local adjustments: dodge-and-burn, healing/retouching, cropping, sharpening, noise reduction. Export settings for web/social/print; editing ethics (enhancement vs. manipulation).
Scripting: Script writing for film, TV, digital media; audience and medium; writing visual action; short film structure; educational and explainer scripts; technical communication through script; writing for voice-over; scene-to-screen adaptation; storyboarding basics; script polishing; group presentation; submission of a short film or explainer script.
Animation: 3D Animation- 3D software interface, basic 3D Modelling, polygon Modelling, materials, textures, UV mapping, lighting and camera setup, rigging fundamentals, character animation with rigs, environment creation, 3D scene animation, rendering techniques, post-processing and compositing.

PL325N LITERATURE & STAGE – 3 (0-0-2) 1

Dramatics: (Directing & Production Design) - Director's vision and role, scene selection, spatial composition (quadrants, levels, body profiles), active-verb rehearsal language, table work, blocking, pacing/transitions, directing labs (actor adjustment, integrating scenography), technical polish, studio trials, final directed-scene showcase → Production design/scenography, lighting and soundscapes, costumes and props, devised theatre foundations, brainstorming/generation, material collation, structuring the piece, integrating technical design, ensemble rehearsals (structure, then timing and choral voice).

Sanskrit Literature: Darshana-Tatha Pariyojana Pramanah: Vidya Sthanani, Vaidika Darshanani – Nyaya, Vaisheshika (Tarkasangraha), Sankhya, Yoga (Patanjali), Kalpa, Purva Mimamsa (Sankshepa), Uttara Mimamsa (Ishavashya, Taittiriya); Avaidika Darshanani – Bauddha, Jaina, Charvaka (Lokayata); Itihasa–Purana – Upabrahmana; Mini Project.
Poetry: Poetry, technology, ecology and society: public project capstone. Students connect poetry with engineering responsibility by engaging with technology, AI, data, automation, cities, labour, infrastructure, ecology, energy, climate, waste, water and sustainability. Writing tasks include poems from the viewpoint of a bridge, traffic signal, algorithm, robot, discarded device, worker, river, tree, sea, plastic bottle or e-waste. Students design and implement a public-facing poetry artifact or project such as a poster, audio piece, digital poem, installation, open mic, anthology, podcast or awareness campaign. The capstone requires audience analysis, project planning, ethical checks, prototype review, implementation, documentation, feedback analysis and a final life-skill reflection linking poetry to engineering identity, human values and social contribution.
Debating & Elocution: (Technical & Professional Communication)- Technical elocution, Q&A handling, translating technical data, case studies, TED-style talks, capstone defense, professional persuasion, tech-debates, AI ethics, data privacy, genetic engineering, sustainability, town-halls, panel discussions, board simulations, crisis management, persuasive leadership.

PL326N MUSIC – 3 (0-0-2) 1

[Carnatic/Hindustani/Instrumental etc]

Carnatic: (Ragas, Varnam & Kriti)- Listening to major ragas and their moods, Varnam I, Simple Kriti I, introduction to Manodharma, group stage performance, individual performances.
Hindustani: (Ragas, Talas & Chota Khayal III)- Theory of ragas and talas, alankaras, aroha-avaroha of ragas, Chota Khayal (Alhaiya Bilawal, Asavari, Kedar, Tilak Kamod, Brindavani Sarang), Rupak Bandhish (Tilak Kamod), Dhamar (Brindavani Sarang), revision with shruti and tala.
Instrumental: Keyboard/Piano — Performance & Advanced Technique: Warm-up and finger independence, scales, arpeggios, dynamics, advanced chord vocabulary (seventh, suspended, diminished, extended chords), advanced progressions (ii–V–I, secondary dominants, chord substitution), dynamic expression (piano, forte, crescendo, articulation, phrasing), rhythm and timing (syncopation, off-beat patterns), melody development and ornamentation, improvisation (scales, chord tones, call-and-response, intros /endings), full song arrangement, accompaniment and ensemble playing, and performance preparation (piece selection, practice schedule, stage presence).

PL327N PAINTING – 3 (0-0-2) 1

Painting & Sketching: (Watercolour Painting): Watercolour materials, fundamental techniques, transparency, brush control, resists and lifting textures, skies and clouds, water and reflections, foliage and trees, linear perspective for urban sketching, brick and stone textures, glass windows, cast shadows with colour washes, final watercolour composition.

Folk Art: The syllabus introduces research and documentation of Indian regional folk-art traditions, covering research methods, topic selection, primary and secondary sources, field observation, interviews, oral history, and visual documentation. Students select one regional art form and study its history, geography, cultural context, visual language, materials, techniques, artists, and contemporary condition, supported by field visits, interviews, photography, sketching, and process documentation. The course also introduces conservation, digital archiving, preservation, revival, and responsible adaptation, culminating in a video documentary, short thesis, or research portfolio.

PL328N SCULPTING – 3 (0-0-2) 1

[Clay Modelling / Craft & Toymaking etc]

Clay Modelling: The syllabus focuses on form development, proportion, balance, advanced hand-building, sculptural forms, surface texture, carving, and improved wheel work. Practical work includes creative hand-built pottery, individual clay sculpture, and refined wheel-thrown forms.
Craft & Toymaking: Paper cutting art, flower vase greeting cards, glass painting, glass-painted greeting cards, Nagomi art with soft pastels, doll making (Russian and Indian dolls), paper collage, Warli-art table mats, stencil spray painting, origami, cubism, and paper mache.

PL329N NCC-CULTURAL ACTIVITY - 5 (0-0-2) 1

Senior Leadership & Section Leading, Advanced Military Repertoire & Fanfares, Display Band Choreography (Formations), Quick-to-Slow March Transitions, Complete RD Parade Drill Integration, Final Performance & Band Pass-Out.

Arnold Myers, Murray Campbell, Christophe Kausel, D. Sharp - The Science of Brass Instruments. Ray Westlake - A Guide to Military Art Bands, Bandsmen and Sheet Music Covers. Trevor Herbert, Helen Barlow - Music & the British Military in the Long Nineteenth Century.

Technical Activities

PL130N INTRODUCTION TO TECHNICAL ACTIVITIES - 1 (0-0-2) 1

Introduction to four technical activities out of eight activities. Introduction to the remaining four activities is part of PL170N in the second semester.

Air/Space Vehicle: Drone, Airplane, Rocket, Satellite etc, - Origin and History of Drones, Airplanes and Rockets, Types and Applications, Underlying Science of Flight, Introduction to Components and Systems, Best Practices, Safety and Responsible Use, Integrated Demonstration, & Assignments.

Introduction to Flight – John D. Anderson

Drone Technology for Beginners - Learn, Build, Fly Drones by Dharna Nar

Basics of Aeromodelling by Vic Smeed

Rocket Propulsion Elements by George P. Sutton, Oscar Biblarz, John Wiley & Sons, 9th Edition

Ground Vehicle: 2-wheeler, 4-wheeler, e-vehicle, Train etc, - Introduction to Electric Vehicles and the Subsystems, Types and Applications, Regulations, Introduction to various sensors, Best Practices, Demonstration, and Assignments.

E. Ehsani, Y. Gao, S.Lango, and E. Kambiz, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Third Edition, Taylor & Francis, 2018.

J. Hayes & Abas Goodarzi, "Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley International, 2018.

Marine Vehicle: Surface, Underwater, Monitoring, Rescue craft etc, - Orientation to underwater vehicles, ocean workplace applications, Basic Ocean environment: depth, pressure, currents, visibility, corrosion and fouling, Introduction to vehicle parts: frame, hull, thrusters, tether, camera, battery and sensors, Demonstration and Assignments.

E.C. Tupper, Introduction to Naval Architecture, Butterworth-Heinemann.

Robert D. Christ and Robert L. Wernli Sr., The ROV Manual: A User Guide for Remotely Operated Vehicles, Butterworth-Heinemann.

Educational Toy: Maths, Physics, Chemistry, Environment etc, - Introduction to Toy Design and Creativity, Basics of Materials and Tools, Sketching and Idea development, Simple Toy Mechanisms, Paper and Cardboard Prototyping, Wooden Toy Basics, Mechanical toy design, Educational toy concepts and Assignments.

Martin Gardner, Dover Publications, 1986.

Peggy Kaye, Pantheon Books, 1988.

Terry Stickels, Jossey-Bass, 2008

Farming & Food: Cultivation, Harvesting, Processing, Packing etc, -Study of key soil properties, including texture, structure, pH, electrical conductivity, moisture, organic matter and cation exchange capacity, along with essential macro- and micronutrients for cashew cultivation, Introduction of portable soil-testing devices, Measurement of essential macro- and micronutrients and Assignments.

Rajendra Prasad 2012. Textbook of Field Crop Production – Food grain Crops Volume I, DKMA, ICAR-KAB I, Pusa, New Delhi.

ICAR–Indian Institute of Soil Science, Soil Health Management for Sustainable Agriculture. Bhopal, India: ICAR-IISS, 2023.

Smart Home: Cookware, Furniture, Storage, Security etc, -Introduction to Smart Home and its applications, Demonstration and operation of induction stove, Safety, energy saving, and maintenance of home appliances, Assignments.

H. Arkin and J. P. Webster, Electrical Installation and Smart Home Technologies, McGraw-Hill.

Ali Ahmadi, Smart Home Systems, Springer

Sustainability: Material, Water, Energy, Soil conservation etc, - Introduction to sustainable technologies in daily life applications, Introduction to solar energy, Wind energy, Wave and small hydro energy fundamentals, Principles of rain water harvesting, Ground water recharge, Assignments.

Robertson, M., Sustainability Principles and Practice. Routledge. 2021. ISBN 9780367365219, Taylor & Francis.
Bakshi, Bhavik R., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019, ISBN 9781108420457.
Wearable Device: Visual & hearing aid, Walking & Mobility, Safety, Health Monitoring etc - Origin & History, key personalities, achievements, underlying science (technical view), tools and techniques, Overview of biomedical and motion sensors: temperature sensor, accelerometer, gyroscope, pressure sensor, best practices, demo, assignment, evaluation.
Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education, 2018.
Albert M. Cook and Jan Miller Polgar, Assistive Technologies: Principles and Practice, 5th Edition, Elsevier, 2023.

PL139N NCC-TECHNICAL ACTIVITY - 1 (0-0-2) 1

General drill instructions, words of command, and position of attention. Savdhan, Vishram, Aaram Se, and Mudna (right, left, and about turns) practice. Kadam sizing, forming teen line, ek line, khuli line, and nikat line formations. Khade Khade Salute Karna: stationary salute practice and correction. Parade Par, Visarjan, Line Tod, Tej Chal se Tham, and Dhire Chal se Tham. Pre-parade rehearsal, dress and bearing check, and weapon training I. Tej Chal se Mudna (turns while marching in step) and Tej Chal se Salute Karna. Tej Kadam Tal se Kadam Badalna (changing step while marching). Formations: Teen 'O' Teen se Ek File, Ek File se Teen 'O' Teen, basic DST procedures, individual words of command practice, and assessment.

DGNCC - NCC Cadet's Handbook; Technical Skills (SD/SW): Foot Drill Section.
Indian Army/DGNCC - Drill Manual (Foot Drill and Words of Command).
DGNCC - DGNCC Drill Manual for Cadets. DGNCC - NCC Instructor's Handbook on Foot Drill.

PL170N INTRODUCTION TO TECHNICAL ACTIVITIES - 2 (0-0-2) 1

Introduction to four technical activities out of eight activities. Introduction to four activities is already studied as part of PL130N in the first semester.

Air/Space Vehicle: Drone, Airplane, Rocket, Satellite etc, - Origin and History of Drones, Airplanes and Rockets, Types and Applications, Underlying Science of Flight, Introduction to Components and Systems, Best Practices, Safety and Responsible Use, Integrated Demonstration, & Assignments.
Introduction to Flight – John D. Anderson
Drone Technology for Beginners - Learn, Build, Fly Drones by Dharna Nar
Basics of Aeromodelling by Vic Smeed
Rocket Propulsion Elements by George P. Sutton, Oscar Biblarz, John Wiley & Sons, 9th Edition
Ground Vehicle: 2-wheeler, 4-wheeler, e-vehicle, Train etc, - Introduction to Electric Vehicles and the Subsystems, Types and Applications, Regulations, Introduction to various sensors, Best Practices, Demonstration, and Assignments.
E. Ehsani, Y. Gao, S. Lango, and E. Kambiz, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Third Edition, Taylor & Francis, 2018.
J. Hayes & Abas Goodarzi, "Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley International, 2018.
Marine Vehicle: Surface, Underwater, Monitoring, Rescue craft etc, - Orientation to underwater vehicles, ocean workplace applications, Basic Ocean environment: depth, pressure, currents, visibility, corrosion and fouling, Introduction to vehicle parts: frame, hull, thrusters, tether, camera, battery and sensors, Demonstration and Assignments.
E.C. Tupper, Introduction to Naval Architecture, Butterworth-Heinemann.
Robert D. Christ and Robert L. Wernli Sr., The ROV Manual: A User Guide for Remotely Operated Vehicles, Butterworth-Heinemann.

Educational Toy: Maths, Physics, Chemistry, Environment etc, - Introduction to Toy Design and Creativity, Basics of Materials and Tools, Sketching and Idea development, Simple Toy Mechanisms, Paper and Cardboard Prototyping, Wooden Toy Basics, Mechanical toy design, Educational toy concepts and Assignments.

Martin Gardner, Dover Publications, 1986.

Peggy Kaye, Pantheon Books, 1988.

Terry Stickels, Jossey-Bass, 2008

Farming & Food: Cultivation, Harvesting, Processing, Packing etc, -Study of key soil properties, including texture, structure, pH, electrical conductivity, moisture, organic matter and cation exchange capacity, along with essential macro- and micronutrients for cashew cultivation, Introduction of portable soil-testing devices, Measurement of essential macro- and micronutrients and Assignments.

Rajendra Prasad 2012. Textbook of Field Crop Production – Food grain Crops Volume I, DKMA, ICAR-KAB I, Pusa, New Delhi.

ICAR–Indian Institute of Soil Science, Soil Health Management for Sustainable Agriculture. Bhopal, India: ICAR-IISS, 2023.

Smart Home: Cookware, Furniture, Storage, Security etc, -Introduction to Smart Home and its applications, Demonstration and operation of induction stove, Safety, energy saving, and maintenance of home appliances, Assignments.

H. Arkin and J. P. Webster, Electrical Installation and Smart Home Technologies, McGraw-Hill.

Ali Ahmadi, Smart Home Systems, Springer

Sustainability: Material, Water, Energy, Soil conservation etc, - Introduction to sustainable technologies in daily life applications, Introduction to solar energy, Wind energy, Wave and small hydro energy fundamentals, Principles of rain water harvesting, Ground water recharge, Assignments.

Robertson, M., Sustainability Principles and Practice. Routledge. 2021. ISBN 9780367365219, Taylor & Francis.

Bakshi, Bhavik R., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019, ISBN 9781108420457.

Wearable Device: Visual & hearing aid, Walking & Mobility, Safety, Health Monitoring etc - Origin & History, key personalities, achievements, underlying science (technical view), tools and techniques, Overview of biomedical and motion sensors: temperature sensor, accelerometer, gyroscope, pressure sensor, best practices, demo, assignment, evaluation.

Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education, 2018.

Albert M. Cook and Jan Miller Polgar, Assistive Technologies: Principles and Practice, 5th Edition, Elsevier, 2023.

PL179N NCC-TECHNICAL ACTIVITY - 2 (0-0-2) 1

Foot drill recap. Arms drill: Savdhan, Vishram, and Aaram Se with rifle. Parade Par and Saj Drill with rifle; Visarjan and Line Tod with rifle. Bhumi Shastra and Uthao Shastra (grounding and picking up arms); Bagal Shastra and Baju Shastra (shoulder and side-arms positions). Introduction and handling of .22 rifle: parts, safety, carrying, and handling. Theory of grouping, shot-group analysis, range procedure, and range safety protocols. Obstacle training: dress, safety measures, ground orientation, and semester evaluation.

DGNCC - NCC Cadet's Handbook; Technical Skills (SD/SW): Foot Drill Section.

Indian Army/DGNCC - Drill Manual (Foot Drill and Words of Command).

DGNCC - DGNCC Drill Manual for Cadets.

DGNCC - NCC Instructor's Handbook on Foot Drill.

PL231N AIR/SPACE VEHICLE - 1 (0-0-2) 1

[Drone/Airplane/Rocket/Satellite etc]

Drone: Overview of drones, their working principles, classifications, and real-world applications, VTOLs, Drone frame types (fixed-wing and multi-rotor) and their design trade-offs, Trusses, stress, strain, and material selection for lightweight and strong drone frames, Fundamentals of flight stability, feedback control systems and introduction to PID control in drones, Tuning PID controllers, understanding their impact on drone, Filters, Components used in drones, Introduction to coding – I & II, Selection of compatible drone components and integration.

Dharna Nar, "Drone Technology for Beginners - Learn, Build, Fly Drones"

Dr. Nitesh Tiwari, Dr. Shekhar Yadav, Dr. V. K. Giri, "Fundamentals of Drone Technology"

John D. Anderson, "Introduction to Flight"

Airplane: Introduction to Design (XFLR 5), Introduction to VLM methods and LLT (XFLR 5), Introduction to CFD - FVM (Ansys Fluent), Geometry Preparation and Mesh Generation (ANSYS Fluent), CFD Solution, Results Analysis and Post-processing, UAV Structures Design – (Fusion/Creo), Static Structural Analysis, Structural Optimization and Design Validation, Explicit Dynamics – Impact Analysis.

John D. Anderson, "Fundamentals of Aerodynamics".

John D. Anderson, "Introduction to Flight".

Rocket: Orientation to the Engineering Development Phase; review of rocket architecture, mission requirements, and design methodology. Rocket configuration development: nose cone, body tube, fins, payload section, motor section, and recovery section. Aerodynamic fundamentals: drag, aerodynamic forces, fin effects, and influence of external geometry. Rocket stability: CG, CP, stability margin, mass distribution, and basic analytical calculations, Development of a baseline rocket model and simulation of altitude, velocity, acceleration, and stability. Parametric design study: effect of fin geometry, rocket dimensions, mass, and payload on simulated performance. Introduction to computational engineering analysis of selected components using appropriate structural/aerodynamic tools. Team-based preliminary rocket design: configuration selection, calculations, CAD modelling, and simulation.

Handbook of Model Rocketry

NASA Glenn (Website)

Rocket Calculator (App)

PL232N GROUND VEHICLE - 1 (0-0-2) 1

[2-Wheeler/4-Wheeler/E-Vehicle/Train etc]

E-Vehicle: Introduction to HEV, PHEV, and EV Power train, Introduction to Energy Storage for EVs: Battery, ultracapacitors, Fuel cells, Overview of Indian and international regulatory requirements for EV Vehicle system, Fundamentals of Vehicle Propulsion, Introduction to Battery Management System (BMS), Introduction to Controllers, sensors, and communication protocols used in Electric Vehicles.

E. Ehsani, Y. Gao, S. Lango, and E. Kambiz, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Third Edition, Taylor & Francis, 2018.

J. Hayes & Abas Goodarzi, "Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley International, 2018.

PL233N MARINE VEHICLE – 1 (0-0-2) 1

[Surface/Underwater/Monitoring/Rescue Craft etc]

Surface: Electronics in wet environments: challenges — conductivity of water, corrosion of contacts, condensation; conformal coating and potting Navigation sensors: IMU (accelerometer/gyro/magnetometer), compass calibration, GPS/GNSS; why GPS fails underwater Marine environmental sensors: water temperature, pressure/depth (MS5837 type), leak detection, water quality (TDS/turbidity/pH overview) Hands-on: interface GPS + IMU + temperature + depth sensors with ESP32; compass calibration exercise Power systems: Li-ion vs LiFePO4, BMS, fusing, kill switch, power budgeting and endurance estimation Communication: RF above water (2.4 GHz, LoRa, GSM), why RF dies underwater, tethers and acoustic links (concept); antenna placement on a vehicle Hands-on: LoRa telemetry link — stream live sensor data from a

sealed enclosure to a laptop dashboard System integration practice: wiring standards, connectors, strain relief, EMI basics; data logging (SD/cloud).

J.C. Payne, The Marine Electrical and Electronics Bible, Sheridan House
N. Calder, Boatowner's Mechanical and Electrical Manual, International Marine
Website: randomnerdtutorials.com (ESP32 sensor/LoRa interfacing tutorials)

Underwater: Review mechanical platform requirements and introduce six-degree-of-freedom motion terms. Thrusters and motors: brushed DC, BLDC, propeller direction and thrust curves. Power source basics: batteries, voltage, current, capacity, connectors and fusing. Water-safe electrical practices: insulation, strain relief, emergency stop and dry testing. Motor drivers and ESCs; PWM command concept and calibration demonstration. Controller options: Arduino, Raspberry-Pi, microcontroller boards and joystick interface. Manual control mapping for surge, sway, heave and yaw using simple logic. Bench test of one motor channel with current measurement and thermal observation. Multi thruster layout exercise: horizontal and vertical thrust balancing. Cable and tether basics: power wires, signal wires, buoyancy and drag effect.

Robert D. Christ and Robert L. Wernli Sr., The ROV Manual: A User Guide for Remotely Operated Vehicles, Butterworth-Heinemann.
Thor I. Fossen, Handbook of Marine Craft Hydrodynamics and Motion Control, Wiley

PL234N EDUCATIONAL TOY - 1 (0-0-2) 1

[Maths/Physics/Chemistry/Environment etc]

Orientation and review of previous semesters; introduction to mathematical toys, puzzles and manipulatives. Brainstorming Mathematics topics (geometry, fractions, number patterns, symmetry, probability) for toy ideas. Study of existing mathematics manipulatives and puzzles; sketching of shortlisted designs. Toy 1 — Design of a geometry puzzle (e.g., tangram or geometric shape-sorter). Fabrication and functional testing. Toy 2 — Design of a fraction/number-sense learning toy (e.g., fraction wheel, abacus). Fabrication and functional testing. Toy 3 — Design of a symmetry/pattern toy (e.g., pattern blocks, symmetry kaleidoscope). Toy 3 — Fabrication, testing and refinement. Toy 4 — Design of a probability/logic board game (e.g., dice-based probability game).

Martin Gardner, Dover Publications,1986
Peggy Kaye, Pantheon Books, 1988
Terry Stickels, Jossey-Bass, 2008

PL235N FARMING & FOOD - 1 (0-0-2) 1

[Cultivation/Harvesting/Processing/Packing etc]

Cultivation: Familiarization with common diseases of cashew and their impact on plant health and productivity. Study of disease symptoms, causal agents, and environmental conditions associated with disease development. Conduct field surveys to inspect cashew orchards and identify visible disease symptoms. Record disease occurrence, estimate disease severity, and maintain field observation records. Collect and classify infected plant samples for symptom analysis and photographic documentation. Analyze field observations to identify affected zones and plan appropriate disease management. Learn the selection of recommended pesticides, preparation of spray mixtures, and safe handling procedures. Perform drone inspection, system calibration, payload setup, and operational safety checks before spraying. Develop flight plans and configure spraying parameters for efficient and uniform pesticide application. Execute precision pesticide spraying in selected cashew orchard plots using the agricultural drone.

S. Tsouros, B. Bibi, and P. G. Sarigiannidis, "A Review on UAV-Based Applications for Precision Agriculture," Information, vol. 10, no. 11, Art. no. 349, 2019, doi: 10.3390/info10110349.
Food and Agriculture Organization of the United Nations (FAO), Guidance on Pest and Pesticide Management Policy Development. Rome, Italy: FAO, 2022.
Indian Council of Agricultural Research (ICAR)–Directorate of Cashew Research, Package of Practices for Cashew Cultivation. Puttur, Karnataka, India: ICAR-DCR, 2023.

Harvesting: Creation of student teams, Literature review and survey of various solutions available for climate controlled microgreen farm enclosure, Identifying the problem statement, Formulating the methodology and the execution timeline, Introduction to the CAD simulation for the specific problem statement, CAD simulation and Modelling CAD simulation and Modelling CAD simulation and Model Validation Procurement of the components and implementation of the solution, Implementation of the solution Prototype preparation, Validation of the implemented solution in real time.

T. Kozai, G. Niu, and M. Takagaki, Plant Factory: An Indoor Vertical Farming System for Efficient Quality Food Production, 2nd ed. Academic Press, 2020.

Pieters, J. G. Greenhouse Climate Control. Wageningen Academic Publishers

E. Ting, The Microgreens Grower's Handbook: A Step-by-Step Guide to Growing Nutrient-Dense Greens Indoors. Gabriola Island, BC, Canada: New Society Publishers, 2020.

Processing: Introduction to soil as an agricultural resource, soil health and crop requirements. Field visit and scientific soil sampling from different locations/depths and sample preparation. Test for physical characteristics—colour, texture, structure, bulk density, porosity, water-holding capacity, soil pH. Measurement of electrical conductivity, soil salinity, organic carbon/matter, nitrogen, phosphorus, potassium, calcium, magnesium, etc. Introduction to biomass, composting, aerobic/anaerobic decomposition, safety and campus biomass survey, particle-size reduction, weighing and introduction to C:N ratio and formulation of biomass mixtures. Construction/initiation of the composting systems, measurement of initial temperature, moisture and physical characteristics; establishment of compost-monitoring records. Practical turning/aeration of compost and study of the relationship between oxygen, moisture and decomposition. Observation of the biological decomposition process, including fungi/decomposer activity and changes in biomass structure. Continued monitoring of temperature, moisture, odour, colour, texture and volume reduction. Diagnosing/troubleshooting poor heating, excessive moisture, anaerobic conditions or slow decomposition. Mid-process scientific assessment covering mass/volume reduction, labour input, process efficiency and treatment comparison.

Indian Council for Agricultural Research (ICAR)–Indian Institute of Soil Science (IISS), Soil Testing in India – Methods Manual, Government of India.

Indian Council for Agricultural Research (ICAR) – Soil Health Card – Government of India.

University of Agricultural Sciences (UAS), GKVK, Bengaluru, Department of Soil Science & Agricultural Chemistry Resource material (regional).

Food and Agriculture Organization (FPO) of the United Nations: On-farm Composting Methods.

PL236N SMART HOME - 1 (0-0-2) 1

[Cookware/Furniture/Storage/Security etc]

Cookware & Furniture: Study of induction heating principle, Detailed study of the induction stove: coil design, IGBT driver circuit, resonant capacitor bank, and cooling requirements. Revisiting the electric kettle Demonstration and guided disassembly of a decommissioned induction stove to identify components and PCB layout. Demonstration and guided disassembly of a decommissioned/upgraded electric kettle to compare construction with the Semester 2 unit. Discussion on electrical safety for switching power electronics, EMI/EMC basics, insulation standards, and common induction-stove failure modes. Introduction to preparing a bill of materials (BOM) for a small induction-stove prototype and kettle prototype. Sourcing indicative component prices from local electrical/electronic suppliers and online vendors; market survey.

B. L. Theraja, "A Textbook of Electrical Technology", S. Chand Publishing.

Manufacturer manuals and datasheets for household induction cooktops and electric kettles (IGBT driver ICs such as IR2153/IR2153D application notes).

Bureau of Indian Standards (BIS) safety guidelines for household induction cooktops and electrical heating appliances (relevant IS codes, e.g. IS 302-2-9)

Storage & Security: Introduction to Wi-Fi modules and IoT concepts, Configuring ESP8266/ESP32 microcontrollers, Connecting the board to a local Wi-Fi hotspot, Understanding HTTP GET/POST requests basics, Creating a free cloud IoT account (e.g., Adafruit IO/ThingSpeak),Sending simple sensor readings to

the cloud, Storing historical cloud data points in online channels, Setting up basic email/web hooks for security triggers, Designing a simple remote status checking page, Testing latency and reliability of cloud data updates.
Wireless Networking and Mobile Data Management by R.K. Ghosh, Springer
Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pearson Education / Prentice Hall
Cloud Computing Solutions: Architecture, Data Storage, Implementation, and Security by Souvik Pal, Dac-Nhuong Le, & Prasant Kumar Pattnaik, Wiley-Scrivener

PL237N SUSTAINABILITY - 1 (0-0-2) 1

[Material/Water/Energy/Soil Conservation etc]

Introduction to Sustainability in Materials Engineering, Demonstration of biodegradable polymers, recycled plastics, bio-based polymers, and polymer recycling techniques, Extraction of proteins from natural resources and showing its diverse applications, Solar energy fundamentals: solar irradiance, the photovoltaic effect, PV cell/module types. Wind energy fundamentals: wind speed/power relationship, turbine types (HAWT/VAWT). Wave and small-hydro energy fundamentals: wave power basics, micro-hydro concepts. Fundamentals of other renewable energy sources, Overview of surface water, rivers, reservoirs, groundwater and rainfall as water resources; regional variability and major water-stress issues in India. Principles of rainwater harvesting, components of rooftop harvesting systems, storage and groundwater recharge; role in reducing freshwater demand. Ecosystem services provided by rivers, lakes and wetlands; impacts of pollution, urbanisation and encroachment; basic concepts of conservation and restoration.
Verma, S. K., & Sonika, A. P. (Eds.). Sustainable Composites for Future Trends in Renewable Energy.2026, Bentham Science Publishers.
Ashby, Michael F. Materials and the environment: eco-informed material choice. Elsevier, 2012.
Harrison, Robert. Sustainable Ceramics: A Practical Approach. Bloomsbury Publishing, 2022.
Chetan Singh Solanki, Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, PHI Learning (2013).

PL238N WEARABLE DEVICE -1 (0-0-2) 1

[Visual & Hearing Aid/Walking & Mobility/Safety/Health Monitoring etc]

Visual & Hearing Aid: Introduction to Assistive Technology, Accessibility, Types of Disabilities, Human-Centered Design, Sensory Substitution, Introduction to Embedded Systems, Arduino Basics, Raspberry Pi Basics, ESP32 Overview, GPIO, Breadboard, Basic Electronic Components, Sensors and Actuators, Ultrasonic Sensor, IR Sensor, LDR, Push Buttons, LEDs, Buzzer, Vibration Motor, Introduction to Artificial Intelligence, Machine Learning Basics, Computer Vision Basics, Speech Recognition, Text-to-Speech, AI Applications.
Charles Platt, Make: Electronics – Learning Through Discovery, 3rd Edition, Maker Media, 2021.
Simon Monk, Programming Arduino: Getting Started with Sketches, 3rd Edition, McGraw-Hill Education, 2020.
Walking & Mobility: Introduction to Walking and Mobility: Meaning and importance of walking and mobility, Role of mobility in health and quality of life, Anatomy of the Lower Limb: Bones and joints of the lower limb, Functional anatomy related to gait, Basic Biomechanics: Principles of biomechanics, Joint motion during walking, Normal Gait: Definition of gait, Gait cycle, Normal gait characteristics, Posture and Balance: Postural control, Factors affecting balance, Assessment of Walking and Mobility: Balance assessment, Basic functional mobility tests, Basic Mobility Skills: Walking and turning, Stair and ramp mobility, Introduction to Mobility Assistance, Principles of safe mobility assistance: Body mechanics, Introduction to mobility aids.
Wearable/Personal Monitoring Devices Present to Future; by Gaetano D. Gargiulo, Ganesh R. Naik; 2021
The Drivers of Wearable Device Usage: Practice and Perspectives, by Claus-Peter H. Ernst, 2016
Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
Health Monitoring: Introduction to bio-signals and sources of noise in wearable sensor data, Basics of digital filtering: moving average, low-pass, and high-pass filters for PPG/temperature signals, Motion signal

processing: accelerometer/gyroscope data smoothing and thresholding, Feature extraction: heart rate from PPG, step count from accelerometer, fall-signature detection, Introduction to fall-detection algorithms (threshold-based and simple pattern-based approaches, Introduction to abnormal vital-sign detection logic (tachycardia/bradycardia, fever thresholds), Design review of the signal-processing pipeline and algorithm flowchart, Procurement and inspection of components for the improved prototype; on-device processing tools, Assembly and testing of the signal-processing pipeline on the wearable hardware, Embedded implementation of filtering and feature-extraction routines on the microcontroller, Integration and validation of the safety/health detection algorithm with live sensor data.

Biomedical Signal Processing: Principles and Techniques — D.C. Reddy, Tata McGraw-Hill, 2005
Digital Signal Processing: A Practical Approach — Emmanuel C. Ifeachor, Barrie W. Jervis, Pearson, 2002

PL239N NCC-TECHNICAL ACTIVITY - 3 (0-0-2) 1

Advanced Arms Drill – Ceremonial Salute (Salami Shastra), .22 Rifle Advanced Marksmanship & Shot-Group Analysis, Introduction to Service Weapons (7.62mm SLR / 5.56mm INSAS), Map Reading – Basics & Conventional Signs, Compass Handling & Service Protractor, Short-Range Live Firing Assessment & Map Navigation Test, Introduction to drones.

DGNCC - NCC Cadet's Handbook; Technical Skills (SD/SW): Foot Drill Section.
Indian Army/DGNCC - Drill Manual (Foot Drill and Words of Command).
DGNCC - DGNCC Drill Manual for Cadets.
DGNCC - NCC Instructor's Handbook on Foot Drill.

PL271N AIR/SPACE VEHICLE - 2 (0-0-2) 1

[Drone/Airplane/Rocket/Satellite etc]

Drone: Overview of electronic system design, components, schematics, and basics of designing circuits for embedded system, Circuit Design and Simulation, Hands-on implementation of designed circuits including prototyping, soldering, and testing, materials like carbon fiber, plastics, and metals with respect to strength, weight, and durability, Intro to CAD tools for designing drone frames and creating basic 3D models, CAD modelling - assembly design, constraints, and preparing models for fabrication, Basics of OpenCV, pixel representation, filtering, and simple transformations, Feature detection, object recognition basics.

Drone Programming: Building and Coding Autonomous UAVs A beginner's guide to drone flight programming and automation by Thompson Carter
Learning ROS for Robotics Programming – Aaron Martinez

Airplane: Engineering Problem Definition and Product Requirement Specification, Concept Generation and Trade-off Analysis, Detailed CAD Design and Assembly (Fusion 360/Creo), Mechanism Design (Payload Release/Landing Gear/Folding Mechanisms), Manufacturing Planning (3D Printing, Laser Cutting, CNC), Prototype Fabrication, Introduction to Flight Controllers (Pixhawk/Ardupilot), Sensors, ESC, Motors and Power System Integration, Mission Planning and Autonomous Mission, Configuration (Mission Planner/Ground Control), Autonomous Flight Control using ArduPilot/PX4, Ground Testing and System Integration, Prototype Demonstration and Flight Readiness Review.

Small Unmanned Aircraft: Theory and Practice – Beard & McLain
Designing Unmanned Aircraft Systems: A Comprehensive Approach – Jay Gundlach
Learning ROS for Robotics Programming – Aaron Martinez
Pixhawk Hardware User Guide and ArduPilot Documentation

Rocket: Structural subsystem development: body, fins, nose cone, joints, mounting arrangements, and payload interfaces, Manufacturing and fabrication methods; material processing, additive manufacturing, assembly, and dimensional verification, Introduction to rocket avionics: sensors, microcontrollers, power supply, data storage, and system architecture, Avionics Workshop: Interfacing IMU, pressure/altitude and other selected sensors with a microcontroller, Data acquisition and flight-data logging; sampling, calibration, storage, and basic signal interpretation, Introduction to telemetry and communication; transmission and

visualization of acquired data, Recovery subsystem engineering: recovery architecture, deployment concepts, parachute sizing, and ground-level deployment testing, Propulsion-system interface and supervised static-test demonstration/data interpretation, with emphasis on thrust-time behaviour and safety.

Rocket Propulsion Elements by George P. Sutton, Oscar Biblarz, John Wiley & Sons, 9th Edition
Model Rocket Design and Construction: How to create and build unique and exciting model rocket that work by Timothy S. Van Milligan, Kalmbach Pub Co, 1995
Website: Open-Rocket Simulator, Spaceflight Simulator

PL272N GROUND VEHICLE - 2 (0-0-2) 1

[2-Wheeler/4-Wheeler/E-Vehicle/Train etc]

E-Vehicle: Role of Power Electronics and Drives in Transportation Electrification, System design considerations, rating, and sizing of electric drivetrain components, Machines and drives for traction and EVs: BLDC, PMSM, IM, SRM, Introduction to software interface and basic Modelling, Control of Electric Drives, Architectures, Modelling, and simulations of electric drivetrains, Design and simulation of basic converter topologies, drivetrains and driving factors, Vehicle System Modelling.
E. Ehsani, Y. Gao, S. Lango, and E. Kambiz, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Third Edition, Taylor & Francis, 2018.
J. Hayes & Abas Goodarzi, "Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley International, 2018.

PL273N MARINE VEHICLE - 2 (0-0-2) 1

[Surface/Underwater/Monitoring/Rescue Craft etc]

Surface: Marine propulsion: propeller basics (pitch, diameter, thrust, cavitation); brushless thrusters, waterjets; thruster placement — differential vs rudder vs vectored, Drivetrain electronics: BLDC motors, ESCs, PWM control; motor–ESC–battery matching; shaft seals and waterproof motors, Hands-on: thrust bench test — measure thrust vs throttle with a load cell; efficiency curves; select thrusters for the project boat, Vehicle controllers: RC systems, microcontroller vs autopilot (ESP32 vs Pixhawk); ArduRover/ArduSub ecosystem, MAVLink and ground control software, Hands-on: set up Pixhawk/ESP32 controller — RC binding, telemetry check, failsafe configuration; install GPS/IMU/depth/leak sensors; EMI considerations — compass calibration away from and near thrusters, sensor placement relative to ESCs and power wiring, Feedback control: open vs closed loop; PID control explained through heading hold; tuning basics (P, then PI, then PID).
Moore, Bohm & Jensen, Underwater Robotics (propulsion & control chapters)
T.I. Fossen, Handbook of Marine Craft Hydrodynamics and Motion Control, Wiley (introductory sections)
Website: ardupilot.org (ArduRover documentation)
Underwater: Sensor overview: camera, lighting, pressure/depth, IMU, compass, sonar and water-quality sensors. Underwater vision: lighting, turbidity, reflections, camera placement and field of view. Depth and pressure sensor basics; calibration and depth estimation exercise. IMU/compass basics: roll, pitch, yaw, drift, noise and mounting orientation. Water-quality sensing: temperature, turbidity, pH/EC awareness and sampling limitations. Data logging using microcontroller or single-board computer; timestamping and file formats. Communication options: tethered serial/Ethernet, acoustic concept and optical limitations. Tether management: strain relief, signal integrity, drag, buoyancy and operator coordination. Sensor fusion concept through simple table-based interpretation of depth and attitude data. Mission navigation sheet: route, depth bands, observation points and data fields.
Robert D. Christ and Robert L. Wernli Sr., The ROV Manual: A User Guide for Remotely Operated Vehicles, Butterworth-Heinemann.
Thor I. Fossen, Handbook of Marine Craft Hydrodynamics and Motion Control, Wiley.
NOAA Ocean Exploration - Underwater Robots / ROVs / AUVs:
https://oceanexplorer.noaa.gov/education/underwater-robots/; WHOI Underwater Vehicles:
https://www.whoi.edu/what-we-do/explore/underwater-vehicles/; MATE ROV: https://materovcompetition.org/

PL274N EDUCATIONAL TOY - 2 (0-0-2) 1

[Maths/Physics/Chemistry/Environment etc]

Orientation and review of previous semesters; introduction to environmental education and sustainability through toys. Brainstorming Environment topics (water cycle, renewable energy, recycling, ecosystems) for toy ideas. Study of eco-friendly toy design using recycled/upcycled materials; sketching of shortlisted designs. Toy 1 — Design of a water-cycle model toy, Fabrication and functional testing. Toy 2 — Design of a mini solar-powered toy/model demonstrating renewable energy, Fabrication and functional testing. Toy 3 — Design of a waste-segregation/recycling game or working model, Fabrication, testing and refinement. Toy 4 — Design of an ecosystem/food-chain board game or model.

Michael L. Roa, Jossey-Bass, 2008.

G. Tyler Miller & Scott Spoolman, Cengage Learning, 2015.

Arvind Gupta, Eklavya, 1993.

PL275N FARMING & FOOD - 2 (0-0-2) 1

[Cultivation/Harvesting/Processing/Packing etc]

Cultivation: Introduction to post-harvest processing and the role of cashew nut sorting machines, Study the construction, working principle, and major components of the sorting machine, Identify mechanical and electrical components, tools, and follow standard safety practices, Assemble the machine frame and install the sorting mechanism, Integrate the drive unit, electrical wiring, and control components, Inspect component alignment, fasten assemblies, and verify system integration, Calibrate the sorting mechanism and adjust operating parameters for accurate sorting, Perform functional testing under different operating conditions and record observations, Diagnose and rectify common mechanical and electrical faults affecting machine performance, Evaluate sorting accuracy, throughput, and operational efficiency using cashew nut samples, Carry out routine maintenance, component inspection, and implement safe operating procedures, Demonstrate complete machine operation, analyze performance results, and prepare a technical report with recommendations for improvement.

P. K. Bala, Agricultural Engineering and Farm Machinery, 2nd ed. New Delhi, India: Standard Publishers Distributors, 2021.

S. Y. Mohammed and K. C. Ting, "Postharvest mechanization and grading systems for agricultural produce: A review," Journal of Food Process Engineering, vol. 45, no. 8, Art. no. e14092, Aug. 2022, doi: 10.1111/jfpe.14092.

Indian Council of Agricultural Research (ICAR)–Directorate of Cashew Research, Package of Practices for Cashew Cultivation. Puttur, Karnataka, India: ICAR-DCR, 2023.

Harvesting: Creation of student teams, Literature review and survey of various solutions available for climate-controlled mushroom farm enclosure, Identifying the problem statement, Formulating the methodology and the execution timeline, Introduction to the CAD simulation for the specific problem statement, CAD simulation and Modelling, Model Validation, Procurement of the components and implementation of the solution, Prototype preparation, Validation of the implemented solution in real time.

P. Stamets and J. S. Chilton, The Mushroom Cultivator: A Practical Guide to Growing Mushrooms at Home. Olympia, WA, USA: Agarikon Press, 1983.

V. N. Pathak, Y. Nagendra, and M. Yadav, Mushroom Production and Processing Technology. Agrobios (India), Jodhpur, India.

Shan Wang, Intelligent Buildings and Building Automation – Sensors, controllers, and smart environmental systems.

Processing: Introduction to compost maturity, curing, stabilization, compost quality and the risks of using immature compost, Diagnosis of fresh, active, partially mature and mature compost using colour, odour, texture, temperature and visual observations, Measurement and interpretation of compost moisture and pH; introduction to C:N ratio and other quality parameters, Manual screening of compost and separation of finished material from coarse/undecomposed biomass for recycling into the composting system, Measurement of

initial/final mass and volume; calculation of compost recovery, volume reduction and basic labour requirements, Establishment/maintenance of vermicompost using suitably pre-composted material; observation of earthworm activity and environmental conditions, Compost maturity assessment using temperature stability, physical indicators and simple maturity criteria, Preparation of a simple seed-germination/maturity experiment comparing compost treatments with a control, Establishment of a small plant-growth experiment using the different composts under controlled conditions, Measurement of germination, plant height, leaf number/biomass and other selected growth indicators; preparation of graphs, Integrated comparison of compost treatments based on quality, maturity, time, labour, biomass recovery and plant response.

University of Agricultural Sciences, GKVK, Bengaluru's Skill-development training in vermicompost production.
Food and Agriculture Organization of the United Nations (FAO), Agricultural and Food Engineering Working Document: Composting.
Indian Council of Agricultural Research (ICAR)–ICAR — Organic Manure Production Training.

PL276N SMART HOME - 2 (0-0-2) 1

[Cookware/Furniture/Storage/Security etc]

Cookware & Furniture: Study of induction heating principle - Detailed study of the induction stove: coil design, IGBT driver circuit, resonant capacitor bank, and cooling requirements and its working principle, Revisiting the electric kettle, Demonstration and guided disassembly of a decommissioned induction stove to identify components and PCB layout, Demonstration and guided disassembly of a decommissioned/upgraded electric kettle to compare construction with the Semester 3 unit.

Discussion on electrical safety for switching power electronics, EMI/EMC basics, insulation standards, and common induction-stove failure modes, Introduction to preparing a bill of materials (BOM) for a small induction-stove prototype and kettle prototype, Sourcing indicative component prices from local electrical/electronic suppliers and online vendors; market survey, Preparation of the combined development budget for a batch prototype (induction stove + kettle) by student teams.

B. L. Theraja, "A Textbook of Electrical Technology", S. Chand Publishing.
Manufacturer manuals and datasheets for household induction cooktops and electric kettles (IGBT driver ICs such as IR2153/IR2153D application notes).
Bureau of Indian Standards (BIS) safety guidelines for household induction cooktops and electrical heating appliances (relevant IS codes, e.g. IS 302-2-9).

Storage & Security: Introduction to local network storage and privacy, Setting up a mini single-board computer, Connecting storage media (USB/SATA drives) to the board, Creating a basic local file-sharing space for home data, Implementing user accounts and access permissions, Introduction to network security keys and Wi-Fi encryption, Configuring basic firewall rules on local networks, Encrypting configuration files and credential storage, Simulating unauthorized login attempts and monitoring logs, Routine automated local data backup scheduling, Group testing of data recovery from local backups.

Guide to Network Security Fundamentals by Mark Ciampa, Cengage Learning.
Storage Area Networks For Dummies by Christopher Poelker and Alex Nikitin, John Wiley & Sons Inc.
Network Security and Management by Brijendra Singh, PHI Learning.

PL277N SUSTAINABILITY - 2 (0-0-2) 1

[Material/Water/Energy/Soil Conservation etc]

Preparation and characterization of natural pH Indicators and dye extraction, Biopolymer extraction and characterization, Ceramics from natural resources, Introduction to what a renewable energy system looks like — the basic block diagram (source → controller → battery → inverter → load),The energy source block — simple explanation of how a solar panel, wind turbine, or wave device produces energy, The battery/storage block — what a battery does, common types used (lead-acid vs. lithium), and the basic idea of charging and discharging, Introduction to sustainable water management; catchment and river-basin perspective; domestic,

agricultural, industrial and ecological water demands; rainfall variability and water availability, Groundwater recharge, abstraction and depletion; urban water supply and distribution losses, wastewater generation, treatment, reuse and circular-water concepts, Integration of water conservation, rainwater harvesting, groundwater recharge, wastewater reuse and demand management.

Charlesworth, S. M., Booth, C. A. and Adeyeye, K. (Eds.), Sustainable Water Engineering: Theory and Practice, Elsevier.

Chetan Singh Solanki, Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, PHI Learning (2013)

Verma, S. K., & Sonika, A. P. (Eds.). Sustainable Composites for Future Trends in Renewable Energy.2026, Bentham Science Publishers.

Ashby, Michael F. Materials and the environment: Eco-informed material choice, Elsevier, 2012.

PL278N WEARABLE DEVICE -2 (0-0-2) 1

[Visual & Hearing Aid/Walking & Mobility/Safety/Health Monitoring etc]

Visual & Hearing Aid: Basics of Sound, Human Hearing, Audio Signals, Frequency, Loudness, Audiograms, Microphones, Speakers, Bone Conduction Basics, Audio Amplifiers, Operational Amplifiers, Volume Control, Digital Images, Pixels, Resolution, Image Enhancement, Contrast Adjustment, Edge Detection, Optical Character Recognition (OCR), Object Detection, Face Detection, Text-to-Speech, Camera Applications, Introduction to Digital Signal Processing, Noise Reduction Basics, Audio Recording, Speech Processing, AI Vision Demonstrations.

Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, Springer, 2022.

Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing, California Technical Publishing, 1997 (freely available and beginner-friendly).

Walking & Mobility: Introduction to Walking and Mobility: Meaning and importance of walking and mobility, Role of mobility in health and quality of life, Anatomy of the Lower Limb: Bones and joints of the lower limb, Functional anatomy related to gait, Basic Biomechanics: Principles of biomechanics, Joint motion during walking

Normal Gait: Definition of gait, Gait cycle, Normal gait characteristics, Posture and Balance: Postural control, Factors affecting balance, Assessment of Walking and Mobility: Balance assessment, Basic functional mobility tests, Basic Mobility Skills: Walking and turning, Stair and ramp mobility, Introduction to Mobility Assistance, Principles of safe mobility assistance: Body mechanics, Introduction to mobility aids.

Wearable/Personal Monitoring Devices Present to Future; by Gaetano D. Gargiulo, Ganesh R. Naik; 2021

The Drivers of Wearable Device Usage: Practice and Perspectives, by Claus-Peter H. Ernst, 2016

Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013

Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014.

Health Monitoring: Introduction to wireless communication protocols for wearables: BLE, Wi-Fi, and an overview of LoRa, Setting up the BLE/Wi-Fi module on the microcontroller (e.g., ESP32 built-in BLE/Wi-Fi), Basics of mobile-app development / no-code app builders for sensor-data visualization, Introduction to cloud IoT platforms for data storage and dashboards (e.g., Firebase, Thing-Speak), Sending sensor and alert data from the wearable device to the cloud/mobile app, Designing a real-time notification system (SMS/app push notification) for safety/health alerts, Design review of the system architecture including connectivity, cloud, and alerting layers, Procurement and inspection of connectivity modules; familiarization with cloud-platform tools, Assembly and testing of the connected wearable prototype (device + app/cloud link), Embedded programming for reliable data transmission and reconnection handling, Integration testing: end-to-end data flow from sensor to alert notification.

Internet of Things: A Hands-On Approach — Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015

Bluetooth Low Energy: The Developer's Handbook — Robin Heydon, Prentice Hall, 2012

PL279N NCC-TECHNICAL ACTIVITY - 4 (0-0-2) 1

Squad Arms Drill & Directing Staff (DST) Procedures, Advanced Firing Positions & Range Management, Tactical Map Reading & Ground Navigation, Drones – Flight Principles & DGCA Regulations, Field Firing Test & Ground Navigation Practical, Design Thinking & Ideation for NCC Idea and Innovation Camp.

DGNCC - NCC Cadet's Handbook; Technical Skills (SD/SW): Foot Drill Section.
Indian Army/DGNCC - Drill Manual (Foot Drill and Words of Command).
DGNCC - DGNCC Drill Manual for Cadets.
DGNCC - NCC Instructor's Handbook on Foot Drill.

PL331N AIR/SPACE VEHICLE - 3 (0-0-2) 1

[Drone/Airplane/Rocket/Satellite etc]

Drone: Capstone project planning; objective finalization, roles, timelines, and review framework, Literature review, design gaps, and innovation opportunities, Design and analysis; mission planning, subsystem refinement, and optimization studies, Prototype Development, Integration, troubleshooting, and deployment planning, Field testing, data logging, and performance evaluation, Competition readiness / internal technical audit, Technical Paper Writing, Intellectual Property, Patents and Technology Commercialization, Industry and research interaction; seminar, alumni review, Capstone project demonstration, final report submission, and activity portfolio evaluation, Research Symposium, Project Expo and Industry Showcase.
Research Methodology – C.R. Kothari
IEEE Editorial Style Manual
WIPO Patent Drafting Manual
Airplane: Engineering Problem Definition and Product Requirement Specification, Concept Generation and Trade-off Analysis, Detailed CAD Design and Assembly (Fusion 360/Creo), Mechanism Design (Payload Release/Landing Gear/Folding Mechanisms), Manufacturing Planning (3D Printing, Laser Cutting, CNC), Prototype Fabrication, Introduction to Flight Controllers (Pixhawk/Ardupilot), Sensors, ESC, Motors and Power System Integration, Mission Planning and Autonomous Mission, Configuration (Mission Planner/Ground Control, Autonomous Flight Control using ArduPilot/PX4, Ground Testing and System Integration, Prototype Demonstration and Flight Readiness Review.
Small Unmanned Aircraft: Theory and Practice – Beard & McLain
Designing Unmanned Aircraft Systems: A Comprehensive Approach – Jay Gundlach
Learning ROS for Robotics Programming – Aaron Martinez
Pixhawk Hardware User Guide and ArduPilot Documentation
Rocket: Introduction to innovation and research in rocket engineering; identification of problems from previous designs and tests, Literature/technical review and benchmarking of existing solutions, Selection of research problems, definition of objectives, requirements, constraints, and measurable performance indicators, Development of baseline model and experimental/computational methodology, Advanced Open Rocket/appropriate computational simulation and sensitivity analysis of selected design parameters, Design optimization and comparison of alternative concepts, Detailed CAD development and engineering analysis of the selected improved component/subsystem, Prototype fabrication/modification and instrumentation planning, Experimental/ground testing and systematic data acquisition. Comparison of experimental and computational results; performance evaluation and identification of discrepancies, Design refinement, re-testing where required, and final validation of the proposed improvement, Research & Innovation Review: Prototype demonstration, technical/research presentation, final documentation, and future-development roadmap.
Rocket Propulsion Elements by George P. Sutton, Oscar Biblarz, John Wiley & Sons, 9th Edition
Model Rocket Design and Construction: How to create and build unique and exciting model rocket that work by Timothy S. Van Milligan, Kalmbach Pub Co, 1995
Website: Open-Rocket Simulator, Spaceflight Simulator

PL332N GROUND VEHICLE - 3 (0-0-2) 1

[2-Wheeler/4-Wheeler/E-Vehicle/Train etc]

E-Vehicle: Introduction to Energy Storage Systems (ESS), High power ultra-capacitors and energy-dense fuel cell systems, Battery energy management techniques, Ultra-capacitor power management techniques, Power electronics for energy and power management, Hybrid energy storage systems and controller development, Charging and infrastructure design, Introduction to workshop safety and machine operation, Working principles of batteries (various chemistries), Introduction to workshop safety and machine operation, High power ultra-capacitors and energy-dense fuel cell systems, Battery energy management techniques, Power electronics for energy and power management, Assembly, quality check, and component integration.
NPTEL Lectures

PL333N MARINE VEHICLE - 3 (0-0-2) 1

[Surface/Underwater/Monitoring/Rescue Craft etc]

Surface: ROV system architecture: frame, buoyancy foam, ballast, pressure housing, thruster layout (vectored 4–6 thruster configs); BlueROV2 reference teardown Pressure and depth: housing design (cylinder vs sphere), end caps, penetrators, vacuum leak testing; depth rating estimation, Tethers and topside: power/data over tether, video transmission, tether drag and management; kill-switch and recovery planning, Underwater acoustics & sonar: sound propagation in water — speed, absorption, multipath, thermoclines; echosounders (single-beam), side-scan and multibeam sonar (overview), Doppler Velocity Log (DVL); hydrophone demo — listening to thruster noise in the tank, Underwater navigation without GPS: depth from pressure, heading from compass, dead reckoning; acoustic positioning — DVL and USBL/LBL concepts (overview), Hands-on: build the pressure housing — acrylic tube, penetrators, vacuum test; install camera and lights, test video over tether, Underwater control: depth-hold and heading-hold with ArduSub; trimming to neutral buoyancy; pilot station setup (joystick + Ground Control).
R.D. Christ & R.L. Wernli, The ROV Manual, Butterworth-Heinemann
H. Bohm & V. Jensen, Build Your Own Underwater Robot, Westcoast Words
Website: ardusub.com (ArduSub docs), materovcompetition.org (mission specs)
Underwater: Autonomy overview: manual, assisted, semi-autonomous and autonomous vehicle operation, Mission planning: waypoints, scan patterns, depth limits, emergency return and abort logic, Feedback control concept: error, setpoint, PID and station-keeping demonstration, Data cleaning: noise, missing readings, moving average and basic filtering, Underwater image issues: low contrast, turbidity, color shift and lighting correction, Object detection concept: debris, pipe, crack, marker or marine feature identification, Mapping basics: grid map, transect, geotagged observations and coverage planning, AI ethics and reliability: false detections, safety, bias and human supervision.

PL334N EDUCATIONAL TOY - 3 (0-0-2) 1

[Maths/Physics/Chemistry/Environment etc]

Orientation; review of Semester-4 toys; selection of best toys for advanced development, Advanced design refinement — improving durability, aesthetics and safety of selected toys, Costing, material-sourcing planning and low-cost production feasibility study, Prototype 2.0 development — refined Physics-based toy, Prototype 2.0 development — refined Chemistry-based toy, Prototype 2.0 development — refined Mathematics-based toy, Prototype 2.0 development — refined Environment-based toy, Preparation of instructional/teacher manuals and a consolidated toy catalogue, Trial demonstration in a school/community setting; feedback collection, Incorporating feedback; final refinements and quality checks, Preparation for final exhibition — displays, posters, and presentation practice, Final exhibition, outreach/donation event, and comprehensive programme documentation and evaluation.
Navi Radjou, Jaideep Prabhu & Simone Ahuja, Jossey-Bass, 2012
Eric Ries, Crown Business, 2011

Everett M. Rogers, Free Press, 2003

PL335N FARMING & FOOD - 3 (0-0-2) 1

[Cultivation/Harvesting/Processing/Packing etc]

Cultivation: Overview of cashew processing and the application of automated peeling machines in post-harvest operations, Examine the design, operating mechanism, and key components of the automated peeling machine, Familiarize with machine parts, assembly tools, electrical connections, and workplace safety requirements, Assemble the structural frame and install the peeling mechanism according to the assembly procedure, Fit the motor, transmission system, sensors, and control unit, and complete electrical interconnections, Verify component alignment, secure all assemblies, and inspect the integrated system before operation, Configure machine settings and carry out calibration to achieve effective peeling performance, Operate the machine under trial conditions and record observations from functional performance tests, Analyze operational issues, perform basic fault diagnosis, and implement corrective measures, Assess peeling efficiency, kernel quality, and processing capacity using representative cashew samples, Conduct preventive maintenance, inspect critical components, and follow standard safety procedures during operation, Demonstrate the fully assembled machine, evaluate overall system performance, and prepare a technical report summarizing the activity and findings.

Indian Council of Agricultural Research (ICAR)–Directorate of Cashew Research, Package of Practices for Cashew Cultivation. Puttur, Karnataka, India: ICAR-DCR, 2023.

C. Chakraverty, A. S. Mujumdar, G. S. V. Raghavan, and H. S. Ramaswamy, Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Boca Raton, FL, USA: CRC Press, 2020.

R. Paul Singh and D. R. Heldman, Introduction to Food Engineering, 6th ed. Cambridge, MA, USA: Academic Press, 2024.

Harvesting: Formulating the methodology and the execution timeline, Introduction to the CAD simulation for the specific problem statement, CAD simulation and Modelling, Model Validation, Procurement of the components and implementation of the solution, Prototype preparation, Validation of the implemented solution in real time, Prototype Expo and final presentation.

Kader, A. A. (Ed.). Postharvest Technology of Horticultural Crops (3rd ed.). University of California, Agriculture and Natural Resources.

Haines, R. W., & Hittle, D. C. (1993). Control Systems for Heating, Ventilating, and Air Conditioning. Springer.

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2025). Principles of Heating, Ventilating, and Air Conditioning (10th ed.)

PL336N SMART HOME - 3 (0-0-2) 1

[Cookware/Furniture/Storage/Security etc]

Cookware & Furniture: Study of PWM Principles, Detailed study of the induction stove: coil design, IGBT driver circuit, resonant capacitor bank, and cooling requirements. Revisiting the electric kettle, Demonstration and guided disassembly of a decommissioned induction stove to identify components and PCB layout, Demonstration and guided disassembly of a decommissioned/upgraded electric kettle to compare construction with the Semester 4 unit, Discussion on electrical safety for switching power electronics, EMI/EMC basics, insulation standards, and common induction-stove failure modes for modern power apparatus, Introduction to preparing a bill of materials (BOM) for a small induction-stove prototype and kettle prototype, Sourcing indicative component prices from local electrical/electronic suppliers and online vendors; market survey, Show demonstration how the induction and kettle work, Presentation and peer review of team budgets and bills of materials; instructor feedback.

B. L. Theraja, "A Textbook of Electrical Technology", S. Chand Publishing

Manufacturer manuals and datasheets for household induction cooktops and electric kettles (IGBT driver ICs such as IR2153/IR2153D application notes)

Bureau of Indian Standards (BIS) safety guidelines for household induction cooktops and electrical heating appliances.

Storage & Security: Defining the comprehensive final system architecture, Integrating secure sensors and microcontrollers, Setting up encrypted local/cloud data transmission, Hardening device passwords and default credentials, Implementing encrypted logging and backup strategies, Testing physical and remote intrusion detection triggers, Simulating a minor network glitch/attack and observing recovery, Optimizing storage usage to prevent memory overflow, Finalizing user interface dashboard and notifications, Complete system dry-run and collaborative peer review, Final integration adjustments and report compilation, Final exhibition, evaluation, and system walkthrough.

Building Smart Home Automation Solutions with Home Assistant by Marco Carvalho, Packt Publishing.

Security in Smart Home Networks by Yan Meng, Haojin Zhu, and Xuemin Shen, Springer.

Smart Home and Industrial IoT Devices by Akashdeep Bhardwaj, Bentham Books.

PL337N SUSTAINABILITY - 3 (0-0-2) 1

[Material/Water/Energy/Soil Conservation etc]

Activated carbon preparation from coconut shell or rice husk, Green synthesis of nanoparticles using plant extracts, Plastic waste recycling and upcycling Power management from solar PV and wind Power converter and control, Hands-on: build/test a simple inverter circuit and observe its output waveform on an oscilloscope, Technology-specific session — Wind/micro-hydro teams: generator working principle (PMSG for wind; induction/synchronous generator for micro-hydro); Solar teams: PV cell semiconductor physics (p-n junction, photovoltaic effect) in more depth, Water Security, Climate Resilience and Nature-Based Solutions: water-security risks under climate variability; drought, flood and urbanisation impacts; wetlands, green infrastructure, sustainable drainage and recharge-based interventions, Activity: analyse a climate-related water problem and select appropriate engineering and nature-based solutions, Smart Monitoring and Decision Support for Sustainable Water Systems: sensors, smart metering, water-level/flow monitoring, GIS, remote sensing, dashboards and basic decision-support concepts, Activity: teams develop a monitoring and decision-support architecture for a building/campus/community water system. Prototype Development, Performance Assessment and Optimization: convert the proposed solution into a conceptual/functional prototype; assess water saving, resource efficiency, environmental benefit, feasibility and scalability, Activity: demonstrate the prototype/concept, quantify its expected performance and propose improvements.

Jiménez-González, Concepción, and David JC Constable. Green and Sustainable Chemistry and Engineering: A Practical Design Approach. John Wiley & Sons, 2025.

Segovia-Hernandez, Juan Gabriel, Nelly Ramírez-Corona, and Valentina Aristizábal-Marulanda, eds. Contributions of Chemical Engineering to Sustainability. Springer, 2024.

Suresh, S., and S. Sundaramoorthy. Green chemical engineering. Boca Raton: CRC Press, 2015.

Charlesworth, S. M., Booth, C. A. and Adeyeye, K. (Eds.), Sustainable Water Engineering, 1st Edition, Elsevier, 2020.

Kolokytha, E., Oishi, S. and Teegavarapu, R. S. V. (Eds.), Sustainable Water Resources Planning and Management Under Climate Change, Springer, 2017

PL338N WEARABLE DEVICE -3 (0-0-2) 1

[Visual & Hearing Aid/Walking & Mobility/Safety/Health Monitoring etc]

Visual & Hearing Aid: System Integration, Embedded AI, Sensor Fusion Basics, Assistive Device Architecture, Bluetooth, Wi-Fi, Mobile Connectivity, IoT Basics, Data Communication Wearable Electronics, Battery Basics, Power Management, Enclosures, Ergonomic Design, Prototype Development, Hardware Integration, Software Integration, Testing and Debugging, Accessibility Standards, User Evaluation, Performance Improvement, Documentation, Project Planning, Final Project Demonstration, Viva, Project Evaluation.

Pete Warden and Daniel Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly Media, 2019.

Donald Norris, Beginning Artificial Intelligence with the Raspberry Pi, Apress, 2021.
Walking & Mobility: Range of motion and functionality testing; Assessing the physical movement, grip strength, and response time against standard human hand capabilities; Signal calibration and machine learning refinement; Fine-tuning the surface electromyography (sEMG) or myoelectric sensors and algorithms to accurately recognize the user's motor intentions in real-time; Patient adaptation and training; Helping the user practice basic tasks (like grasping, pinching, and opening) so they can adapt to controlling the device; Aesthetic and comfort adjustments; Finalizing the outer cosmetic shell, socket fit, and weight distribution for daily wear.
Wearable/Personal Monitoring Devices Present to Future; by Gaetano D. Gargiulo, Ganesh R. Naik; 2021
The Drivers of Wearable Device Usage: Practice and Perspectives, by Claus-Peter H. Ernst, 2016
Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014.
Health Monitoring: Introduction to AI/ML approaches for wearable health analytics: anomaly detection and classification basics, Data collection and labelling from prior semesters' devices for model training, Training a simple ML/rule-hybrid model for health-anomaly or activity classification, Basics of deploying lightweight ML models on microcontrollers (overview of TinyML), Enclosure and ergonomic design considerations for wearable safety/health devices, Power optimization: battery-life estimation, sleep modes, and an overview of energy harvesting, Design review of the final system architecture, integration plan, and validation criteria, Procurement and inspection of final components; assembly of the enclosure and complete hardware, Assembly and testing of the fully integrated wearable device (sensing, processing, connectivity, ML), Embedded implementation of ML/anomaly-detection logic together with connectivity and alerting, System-level validation: accuracy, reliability, and safety testing of the complete device, Final project demonstration, technical presentation, and report submission.
TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers — Pete Warden, Daniel Situnayake, O'Reilly, 2019
Wearable Sensors: Fundamentals, Implementation and Applications — Edward Sazonov, Michael R. Neuman, Academic Press, 2014

PL339N NCC-TECHNICAL ACTIVITY - 5 (0-0-2) 1

Senior Weapons Drill – Ceremonial Guards & Rehearsals, Field Engineering & Night Navigation, Practical Drone Piloting & Manual Flight Operations, Tactical Applications of Drones in Military/NCC Operations, Integrated Tactical Exercise (Map, Weapon & Drone Combined), Cane drill and sward drill, Comprehensive Technical Evaluation & Pass-Out.

DGNCC – NCC Cadet's Handbook; Technical Skills (SD/SW): Foot Drill Section.
Indian Army/DGNCC – Drill Manual (Foot Drill and Words of Command).
DGNCC – DGNCC Drill Manual for Cadets.
DGNCC – NCC Instructor's Handbook on Foot Drill.

Professional Activities

PL140N PROFESSIONAL COMMUNICATION - 1 (0-0-2) 1

Orientation, diagnostic speaking assessment, and fundamentals of effective communication. Verbal and non-verbal communication: body language, paralanguage, proxemics. Introduction to Group Discussion: purpose, formats, evaluation criteria. Types of GD: topic-based, abstract, case-based discussions. Listening skills for discussions; turn-taking and active engagement. GD strategies: initiation, building arguments, supporting with examples. Managing interruptions, consensus building, and summarisation techniques. Mock GD rounds with peer and instructor feedback. Basics of Public Speaking; overcoming stage fear; structuring speech, elevator pitch. Presentation structure: introduction, body, conclusion; clarity and coherence. Designing effective PPT slides, visual aids, and delivery techniques. Case-based Communication Simulations, Interpersonal communication, Individual presentation assessment and reflective feedback incorporation.

Francis Petes S J. 2011.Soft Skills and Professional Communication. New Delhi: McGraw-Hill Education.
Meenakshi Raman and Prakash Singh, 2022. Technical Communication, Oxford University Press.
Klaff, Oren (2011). Pitch Anything: An Innovative Method for Presenting, Persuading, and Winning the Deal. Random House Business Books
Handbook: Holtzhausen, D., & Zerfass, A. (Eds.). (2015). The Routledge handbook of strategic communication. Routledge.
SWAYAM: Enhancing Soft Skills and Personality by Prof. T. Ravichandran (IIT Kanpur)
SWAYAM: Effective Communication Skills for Personal and Professional Development (Prof. Neha Pandey and Prof. Arti Nirmal, BHU)

PL149N NCC-PROFESSIONAL COMMUNICATION - 1 (0-0-2) 1

Orientation, diagnostic speaking assessment, and fundamentals of effective communication. Verbal and non-verbal communication: body language, paralanguage, proxemics. Introduction to Group Discussion: purpose, formats, evaluation criteria. Types of GD: topic-based, abstract, case-based discussions. Listening skills for discussions; turn-taking and active engagement. GD strategies: initiation, building arguments, supporting with examples. Managing interruptions, consensus building, and summarisation techniques. Mock GD rounds with peer and instructor feedback. Basics of Public Speaking; overcoming stage fear; structuring speech, elevator pitch. Presentation structure: introduction, body, conclusion; clarity and coherence. Designing effective PPT slides, visual aids, and delivery techniques. Case-based Communication Simulations, Interpersonal communication, Individual presentation assessment and reflective feedback incorporation.

Francis Petes S J. 2011. Soft Skills and Professional Communication. New Delhi: McGraw-Hill Education; Meenakshi Raman and Prakash Singh, 2022. Technical Communication, Oxford University Press;
Klaff, Oren (2011). Pitch Anything: An Innovative Method for Presenting, Persuading, and Winning the Deal. Random House Business Books;
Holtzhausen, D., & Zerfass, A. (Eds.). (2015). The Routledge handbook of strategic communication. Routledge; SWAYAM: Enhancing Soft Skills and Personality by Prof. T. Ravichandran (IIT Kanpur); SWAYAM: Effective Communication Skills for Personal and Professional Development (Prof. Neha Pandey and Prof. Arti Nirmal, BHU).

PL180N PROFESSIONAL COMMUNICATION - 2 (0-0-2) 1

Introduction to employability communication; an overview of the recruitment process. Resume fundamentals: structure, formatting, key sections. Writing achievement-oriented bullet points; action verbs; quantification. Tailoring resumes for internships, placements, and higher studies. Crafting compelling emails; aligned with the job description. LinkedIn profile basics; professional etiquette and digital presence. SOP Writing: Structuring SOPs for universities, research programmes and internships, Short technical writing exercises. Types of interviews: HR, technical, behavioural, and stress interviews. Answering techniques: behavioural, Abraham

Lincoln, parroting, reframing, row boat techniques. Reasons for failure and post-interview follow-ups. Telephonic and online interviews; professional etiquette. Mock Interview rounds with structured feedback.

Rizvi, M. A. (2017). Effective technical communication (2nd ed.). McGraw Hill Education.
Cottrell, S. (2015). Skills for success: Personal development and employability (3rd ed.). Palgrave Macmillan.
Mitra, B. K. (2016). Personality development and soft skills. Oxford University Press.
Handbook: Knapp, M. L., & Daly, J. A. (Eds.). (2011). The SAGE Handbook of Interpersonal Communication (2nd ed.). Sage Publications
SWAYAM: (online) Enhancing Soft Skills and Personality by Prof. T. Ravichandran (IIT Kanpur) SWAYAM. (online) Effective Communication Skills for Personal and Professional Development
(Prof. Neha Pandey and Prof. Arti Nirmal, BHU)

PL189N NCC - PROFESSIONAL COMMUNICATION - 2 (0-0-2) 1

Introduction to employability communication; an overview of the recruitment process. Resume fundamentals: structure, formatting, key sections. Writing achievement-oriented bullet points; action verbs; quantification. Tailoring resumes for internships, placements, and higher studies. Crafting compelling emails; aligned with the job description. LinkedIn profile basics; professional etiquette and digital presence. SOP Writing: Structuring SOPs for universities, research programmes and internships, Short technical writing exercises. Types of interviews: HR, technical, behavioural, and stress interviews. Answering techniques: behavioural, Abraham Lincoln, parroting, reframing, row boat techniques. Reasons for failure and post-interview follow-ups. Telephonic and online interviews; professional etiquette. Mock Interview rounds with structured feedback.

Rizvi, M. A. (2017). Effective technical communication (2nd ed.). McGraw Hill Education;
Cottrell, S. (2015). Skills for success: Personal development and employability (3rd ed.).
Palgrave Macmillan; Mitra, B. K. (2016). Personality development and soft skills. Oxford University Press; Knapp, M. L., & Daly, J. A. (Eds.). (2011). The SAGE Handbook of Interpersonal Communication (2nd ed.). Sage Publications;
SWAYAM: Enhancing Soft Skills and Personality by Prof. T. Ravichandran (IIT Kanpur); SWAYAM: Effective Communication Skills for Personal and Professional Development (Prof. Neha Pandey and Prof. Arti Nirmal, BHU).

PL240N PROFESSIONAL COMMUNICATION - 3 (0-0-2) 1

Biodata / Profile: Profile photo, Biodata formatting, Layout design, and building an Online profile (LinkedIn/Portfolios). Professional Mails: Email drafting mechanics, managing Recipients (To/CC/BCC), professional Replying, and inbox Archiving workflows. Culture & Etiquette: Business Greetings, Meeting decorum, professional Departing protocols, and strategic Follow-up actions.

PL249N NCC - PROFESSIONAL COMMUNICATION - 3 (0-0-2) 1

Orientation to leadership as a life skill, NCC training philosophy, and leadership expectations. Self-awareness exercises: strengths, weaknesses, values, habits, and personal leadership profiles. Motivation sources, willpower, purpose, and action-plan goal setting. Discipline, duties of a good citizen, punctuality, responsibility, and accountability. Trait-to-action exercises: alertness, initiative, decisiveness, courage, enthusiasm, loyalty, justice, and sense of duty. Character development, integrity, moral courage, and honesty. Time management: prioritization, planning, deadlines, and avoiding procrastination. Perception, empathy, active listening, and interpersonal communication exercises. Verbal/non-verbal communication, concise briefing, questioning, feedback, and professional etiquette. Teamwork dynamics: roles, cooperation, trust, inclusion, and problem-solving techniques. Scenario-based decision making under limited time/information, after-action reviews, group discussion, public speaking, and semester leadership challenge exercises.

DGNCC - NCC Cadet's Handbook / Common Subjects (Leadership and Personality/Character Development).
DGNCC - NCC Common Subject Curriculum/Material on Personality Development and Leadership.

PL280N PROFESSIONAL COMMUNICATION - 4 (0-0-2) 1

Group Discussion: Strategic Introductions, active Contribution techniques, and constructive Conflict resolution within teams. Personal Interview: Professional Dress codes, impactful Introductions, structured Answering methods (STAR technique), and formal Concluding.

PL289N NCC - PROFESSIONAL COMMUNICATION - 4 (0-0-2) 1

Leadership review, personal growth audit, and goal alignment. Leadership styles and situational leadership models. Planning and organizing: objective setting, resource identification, task allocation, timelines, and contingency planning. Delegation, accountability, micromanagement avoidance, feedback, and corrective actions. Critical/creative thinking and simple decision frameworks. Conflict management, negotiation, interest identification, and assertive communication. Stress response recognition, emotional regulation, resilience, and maintaining effectiveness under pressure.

DGNCC - NCC Cadet's Handbook / Common Subjects (Leadership and Personality/Character Development).
DGNCC - NCC Common Subject Curriculum/Material on Personality Development and Leadership.

PL340N PROFESSIONAL COMMUNICATION - 5 (0-0-2) 1

Technical Article: Standard structural framework, generating academic Contents, embedding technical Graphics, and citation References. Poster Presentation: Design Layouts, visual design principles, extracting concise Contents, and verbal presentation delivery. Slide Presentation: Effective Layout frameworks, balancing Text & fonts, utilizing operational Graphics, and high-impact presentation delivery.

PL349N NCC - PROFESSIONAL COMMUNICATION - 5 (0-0-2) 1

Advanced leadership communication: team briefings, instruction delivery, and difficult conversations. Professional group discussions, structured arguments, and consensus building. Interview readiness, behavioral questions, body language, ethical leadership, moral dilemmas, team challenges under constraints, nation-building leadership, and capstone team project execution.

DGNCC - NCC Cadet's Handbook / Common Subjects (Leadership and Personality/Character Development).
DGNCC - NCC Common Subject Curriculum/Material on Personality Development and Leadership.

Department of Chemical Engineering (CH)
Bachelor of Technology in Chemical Engineering

Basic Science Core Courses (BSC)

PH100N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
MA100N	Numerical Methods	(3-0-0)3
MA104N	Ordinary Differential Equations and Transforms	(3-0-0)3
UC102N	Biology and Environment	(3-0-0)3

General Engineering Courses (GEC)

UC101N	Introduction to Engineering	(2-0-2)3
CS101N	Computer Programming	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Humanities and Social Sciences Core Courses (HSC)

UC103N	Indian Knowledge System	(3-0-0)3

Programme Core Courses (PC)

CH200N	Process Calculations	(2-1-0)3
CH201N	Fluid Flow and Particulate Technology	(2-1-0)3
CH202N	Chemical Engineering Thermodynamics	(2-1-0)3
CH203N	Principles of Heat and Mass Transfer	(2-1-0)3
CH204N	Heat Transfer Practice	(0-1-4)3
CH205N	Fluid Flow and Particulate Technology Practice	(0-1-4)3
CH250N	Chemical Process Industries and Pollution Control	(3-0-0)3
CH251N	Mass Transfer Operations	(2-1-0)3
CH252N	Chemical Reaction Engineering - I	(2-1-0)3
CH253N	Transport Phenomena	(2-1-0)3
CH254N	Computational Methods in Chemical Engineering	(2-1-0)3
CH255N	Mass Transfer Practice	(0-1-4)3
CH300N	Chemical Reaction Engineering - II	(2-1-0)3
CH301N	Process Dynamics and Control	(2-1-0)3
CH302N	Process Equipment Design & Simulation	(1-1-2)3
CH303N	Chemical Reaction Engineering Practice	(0-1-4)3
CH304N	Process Dynamics and Control Practice	(0-1-4)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Specific Elective Courses (PSE)

CH350N	Process Instrumentation	(3-0-0)3
CH351N	Energy Technology	(3-0-0)3
CH352N	Petroleum Refining Processes	(3-0-0)3
CH400N	Biochemical Engineering	(3-0-0)3
CH401N	Introduction to Molecular Simulations	(2-1-0)3
CH402N	Fuel Cell Engineering	(3-0-0)3
CH450N	Chemical Project Engineering	(3-0-0)3
CH451N	Energy Conservation and Management in Process industries	(3-0-0)3

Internship / Major Project (MP)

CH398N	Internship - I	(0-0-18)9
CH399N	Major Project - I	(0-0-18)9
CH397N	Design Project	(0-0-18)9
CH448N	Internship - II	(0-0-18)9
CH449N	Major Project - II	(0-0-18)9
CH498N	Internship - III	(0-0-18)9
CH499N	Major Project - III	(0-0-18)9

Honors Courses (Optional)

Students seeking an Honors degree shall credit a minimum of 15 additional credits from Postgraduate courses offered by the parent Department, as decided by the DUGC.

Suggested Plan of Study for B.Tech. in Chemical Engineering:

Slot / Semester	I	II	III	IV	V	VI	VII	VIII
1	PH100N	CY100N	CH200N	CH250N	CH300N	CH397N / CH398N / CH399N	CH448N/ CH449N	CH498N/ CH499N
2	MA104N	MA100N	CH201N	CH251N	CH301N	DEC-1	DEC-4	DEC-6
3	UC101N	UC100N	CH202N	CH252N	CH302N	DEC-2	DEC-5	DEC-7
4	UC102N	UC103N	CH203N	CH253N	CH303N	DEC-3		
5	CS101N	DE100N	CH204N	CH254N	CH304N			
6	PL1XWN / PL1X9N	PL1YWN / PL1Y9N	CH205N	CH255N	PL3XWN / PL3X9N			
7			PL2XWN / PL2X9N	PL2YWN/ PL2Y9N				

Requirements for B.Tech. in Chemical Engineering:

Course Component	Symbol	Credits
Basic Sciences Courses	BSC	20
General Engineering Courses	GEC	12
Life Skill Courses	LSC	20
Programme Core Courses	PCC	51
Dept/Institute Elective Courses	DEC	21
Internships/Major Project Courses	IPC	27
Total		151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

CH200N PROCESS CALCULATIONS (2-1-0) 3

Introduction to stoichiometry and its fundamental concepts; ideal and non-ideal solutions; vapor–liquid equilibrium (VLE), vapor pressure, and partial pressure; saturation and humidity concepts, including the use of humidity charts; steady-state material balance calculations for non-reactive systems with degrees of freedom (DoF) analysis; material balance calculations involving chemical reactions and introduction to unsteady-state processes; material balance calculations for systems with recycle, bypass, and purge streams; energy balances covering thermophysical and thermochemical concepts, including sensible heat, latent heat of phase change, and standard heat of reaction; and integrated material and energy balance calculations for combustion processes.

D.M. Himmelblau, Basic Principles and calculations in Chemical Engg. 9th Edition, Prentice Hall of India. 2022
Narayanan, K. V., & Lakshmikutty, B. (2016). Stoichiometry and process calculations (2nd ed.). Prentice Hall India
Bhatt, B. I., Thakore, S. B., & Shah, S. R. (2021). Stoichiometry (6th ed.). Tata McGraw-Hill

CH201N FLUID FLOW AND PARTICULATE TECHNOLOGY (2-1-0) 3

Fluid properties and flow fundamentals; laminar and turbulent flow; flow through pipes, channels, packed and fluidized beds; dimensional analysis and flow measurement; pumps, compressors, agitation, and mixing; particle characterization, size reduction and enlargement; sedimentation; mechanical separations including screening and filtration; and gas–solid separation processes such as cyclones, bag filters, and electrostatic precipitators.

McCabe W.L., Smith J.C., P Harriot, Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014
Fox, R. W., McDonald, A. T., & Mitchell, J. W. (2020). Fox and McDonald's introduction to fluid mechanics (10th ed.). Wiley
Richardson, J. F., Harker, J. H., & Backhurst, J. R. (2002). Coulson and Richardson's chemical engineering, Volume 2A: Particulate systems and particle technology (6th ed.). Butterworth-Heinemann

CH202N CHEMICAL ENGINEERING THERMODYNAMICS (2-1-0) 3

First law of thermodynamics for closed and open systems, including internal energy and heat and mass balances; equations of state for ideal and non-ideal gases and gas mixtures, and PVT relationships; second law of thermodynamics, entropy, heat engines, refrigeration, heat pumps, and liquefaction processes; thermodynamic properties of pure fluids, property relations, residual properties, and thermodynamic charts; and solution thermodynamics covering partial molar, residual and excess properties, fugacity, activity coefficients, Gibbs–Duhem equation, and applications to vapor–liquid equilibrium (VLE) and other phase equilibria.

Smith, J.M, and H.C. Van Ness -Introduction to Chemical Engineering Thermodynamics, 4th edition, McGraw - Hill.
Elliott, J. R., & Lira, C. T. (2012). Introductory chemical engineering thermodynamics (2nd ed.). Pearson.
Rao, Y.V.C. - Introduction to Chemical Engineering Thermodynamics, Wiley Eastern, 1994.
Narayanan, K. V. (2013). A textbook of chemical engineering thermodynamics (2nd ed.). PHI Learning.

CH203N PRINCIPLES OF HEAT AND MASS TRANSFER (2-1-0) 3

Introduction to heat transfer and its modes; steady and transient heat conduction through plane, cylindrical, and spherical systems; heat transfer with extended surfaces, internal heat generation, and insulation; convective heat transfer including forced and natural convection, film and overall heat transfer coefficients; thermal radiation and fundamental radiation laws; analogies between momentum, heat, and mass transfer, and transport correlations; convective heat transfer with phase change including boiling and condensation;

principles and analysis of heat exchangers and evaporation; fundamentals of mass transfer, molecular diffusion in gases and liquids under steady-state conditions, diffusion through variable cross-sectional areas, diffusion coefficients, and Fick's laws; convective mass transfer, mass transfer coefficients, mass transfer theories, and interphase mass transfer with individual and overall mass transfer coefficients.

Bergman, T. L., Lavine, A. S., Incropera, F. P., & DeWitt, D. P. (2017). Fundamentals of heat and mass transfer (8th ed.). Wiley
Dutta, B. K. (2007). Principles of mass transfer and separation processes. Prentice-Hall of India
Geankoplis, C. J., Hersel, A. A., & Lepek, D. H. (2018). Transport processes and separation process principles (5th ed.). Pearson / Prentice Hall
Çengel, Y. A., & Ghajar, A. J. (2020). Heat and mass transfer: Fundamentals and applications (6th ed.). McGraw-Hill Education

CH204N HEAT TRANSFER PRACTICE (0-1-4) 3

Experiments based on Heat Transfer course. Fundamentals of heat conduction, convection, and radiation; combined convection and radiation heat losses; design and analysis of double-pipe, plate, shell-and-tube, spiral plate, coil, jacketed vessel, packed bed, and condenser heat exchangers; and problem-solving in conduction, convection, radiation, heat exchanger analysis (LMTD and Effectiveness–NTU methods), and single- and multi-effect evaporators.

Incropera, F. P., & DeWitt, D. P. (2002). Fundamentals of heat and mass transfer (5th ed.). John Wiley & Sons
Holman, J. P. (2002). Heat transfer (9th ed.). McGraw-Hill
Kern, D. Q. (1997). Process heat transfer. Tata McGraw-Hill

CH205N FLUID FLOW AND PARTICULATE TECHNOLOGY PRACTICE (0-1-4) 3

Laboratory experiments based on the principles of fluid flow and particulate technology, including fluid flow through pipes, fittings, flow meters, packed and fluidized beds, and centrifugal pumps; filtration, size reduction, particle size analysis, sedimentation, cyclone separation, and froth flotation; along with problem-solving exercises on flow measurement, piping systems, packed and fluidized beds, size reduction, filtration, sedimentation, and elutriation.

McCabe, W. L., Smith, J. C., & Harriott, P. (2014). Unit operations of chemical engineering (7th ed.). McGraw-Hill Education
Coulson, J. M., Richardson, J. F., Backhurst, J. R., & Harker, J. H. (2002). Coulson and Richardson's chemical engineering (Vols. 1 & 2). Butterworth-Heinemann
Rhodes, M. (2008). Introduction to particulate technology (2nd ed.). John Wiley & Sons

CH250N CHEMICAL PROCESS INDUSTRIES AND POLLUTION CONTROL (3-0-0) 3

Overview of chemical process industries, unit operations, unit processes, and process flow diagrams; manufacturing processes for chlor-alkali products, sulfuric acid, ammonia, urea, petroleum refining, pulp and paper, and major polymers; fundamentals of industrial pollution, emission standards, water and wastewater treatment, air and noise pollution control, solid waste management, process safety, carbon capture, and green energy technologies.

Rao, M. Gopala. (1997). Dryden's outlines of chemical technology (3rd ed.). Affiliated East-West Press
Mahajan, S. P. (1990). Pollution control in process industries. Tata McGraw-Hill.
C. S. Rao (1992). Environmental pollution control engineering. Wiley Eastern
Metcalf & Eddy, Inc. (2017). Wastewater engineering: Treatment and reuse (5th ed.). McGraw-Hill Education

CH251N MASS TRANSFER OPERATIONS (2-1-0) 3

Fundamentals of mass transfer and separation processes; gas absorption and gas–liquid contact equipment; distillation, including batch, flash, steam, packed and tray columns, azeotropic and multicomponent distillation; liquid–liquid extraction and leaching operations; adsorption processes and fixed-bed adsorption; humidification, dehumidification, and cooling towers; and principles, design, and operation of drying and crystallization processes.

TreybalR. E- Mass-Transfer Operations, Third Edition, McGraw-Hill International Edition (1981).
Dutta B.K- Principles of Mass Transfer and Separation Processes, Prentice-Hall of India Private Ltd. (2007).
Geankoplis C J, Hersel A H, Lepek D H -Transport Processes and Separation Process Principles. Fifth Edition, Prentice Hall (2018)
McCabe W.L., Smith J.C., Harriot P, Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014

CH252N CHEMICAL REACTION ENGINEERING –I (2-1-0) 3

Chemical reaction equilibrium; kinetics of homogeneous reactions; analysis of batch reactor data; design and performance of isothermal ideal reactors including batch, plug flow, mixed flow, recycle, and autocatalytic reactors; reactor design for single and multiple reactions, including series and parallel reaction systems; product distribution and reactor sizing; and fundamentals of enzyme kinetics, fermentation, enzymatic reactors, and competitive and non-competitive inhibition.

Smith, J. M. (1981). Chemical engineering kinetics (3rd ed.). McGraw-Hill
Levenspiel, O. - Chemical Reaction Engineering, 3rd edition, Wiley Eastern Limited, 2001
Fogler, H.S - Elements of Chemical Reaction Engineering, 3rd edition, Prentice Hall of India,2004

CH253N TRANSPORT PHENOMENA (2-1-0) 3

Fundamentals of molecular, convective, and interphase transport; transport coefficients, dimensionless numbers, transport correlations, and analogies; conservation equations for mass, momentum, energy, and species; steady-state microscopic shell balances for momentum, heat, and mass transfer with and without generation; and steady- and unsteady-state one-dimensional diffusion and convection problems involving momentum, heat, and species transport.

R.B. Bird, W.E. Stewart and E.W. Lightfoot - Transport Phenomena, Revised 2nd Edition. John Wiley &Sons, 2007.
Joel L. Plawsky, Transport Phenomena Fundamentals, 4th Edition, CRC Press T&F Group, 2019.
V. Kumaran, Fundamentals of Transport Processes with Applications, Cambridge University Press, 2023

CH254N COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING (2-1-0) 3

Introduction to computational methods and MATLAB programming for chemical engineering; numerical errors and error analysis; solution of linear and nonlinear algebraic equations; regression analysis and parameter estimation; numerical differentiation and integration; numerical solution of ordinary and partial differential equations using finite difference, Euler, Runge–Kutta, and multistep methods; boundary value problems; and applications to material and energy balances, thermodynamics, reaction engineering, heat and mass transfer, transport phenomena, and reactor Modelling using MATLAB.

Gupta, S. K. (2003). Numerical methods for engineers (paperback ed.). New Age International Publishers
Kaisare, N. S. (2017). Computational techniques for process simulation and analysis using MATLAB (paperback ed.). CRC Press
Ramirez, W. F. (1997). Computational methods for process simulation (2nd ed., paperback ed.). Butterworth-Heinemann

CH255N MASS TRANSFER PRACTICE (0-1-4) 3

Laboratory experiments on diffusion, drying, liquid–liquid extraction, leaching, adsorption, vapor–liquid equilibrium, steam and binary distillation, and mass transfer equipment; demonstrations of tray towers and gas–liquid contactors; and problem-solving sessions on distillation, leaching, fixed-bed adsorption, humidification, dehumidification, and drying operations.

Treybal, R. E. (1981). Mass-transfer operations (3rd ed.). McGraw-Hill.
Dutta, B. K. (2007). Principles of mass transfer and separation processes (paperback ed.). PHI
Geankoplis, C. J., Hersel, A. A., & Lepek, D. H. (2018). Transport processes and separation process principles (5th ed.). Prentice Hall.
McCabe W.L., Smith J.C., P Harriot, Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014

CH300N CHEMICAL REACTION ENGINEERING - II (2-1-0) 3

Review of rate expression for homogeneous and heterogeneous reactions; Concept of non-

ideal flow using residence time distribution (RTD) theory; Prediction of conversion in a non-Ideal reactors using zero, one and two parameter models; Effect of temperature on reactor parameters; Steady-state non-isothermal reactor design, CSTR with Heat Effects - Ignition-Extinction curves and thermal runaway reactions.; Kinetics of fluid-particle reactions using Shrinking Core Model (SCM); Design of non-catalytic gas solid reactors: Kinetics of catalytic reaction using LHHW models; Solid catalysed reactions- Isothermal Intraparticle diffusion-Thiele modulus and effectiveness factor; Rate and performance equations for catalyst deactivation.

Smith, J. M. (1981). Chemical engineering kinetics (3rd ed.). McGraw-Hill.
Leven spiel, O. (1999). Chemical reaction engineering (3rd ed.). John Wiley & Sons
Fogler, H. S. (2004). Elements of chemical reaction engineering (3rd ed.). Prentice-Hall of India.
Forment, G. F., & Bischoff, K. B. (1990). Chemical reactor analysis and design. John Wiley & Sons

CH301N PROCESS DYNAMICS AND CONTROL (2-1-0) 3

Introduction to process dynamics and control, process variables, feedback and feedforward control, and Laplace transforms; dynamic Modelling of first- and second-order systems, transfer functions, and linearization; transient analysis of open- and closed-loop systems, including time-delay and FOPDT models; control actions (P, PI, PD, PID) and closed-loop transfer functions; servo and regulator responses, offset, and controller selection; stability analysis using Routh–Hurwitz, root locus, Bode, and Nyquist methods; and PID controller design and tuning using Ziegler–Nichols and Cohen–Coon methods.

Seborg, D. E., Edgar, T. F., & Mellichamp, D. A. (2004). Process dynamics and control (2nd ed.). John Wiley & Sons.
Stephanopoulos, G. (1984). Chemical process control: Theory and practice (paperback ed.). PHI India
Coughanowr, D. R., & LeBlanc, S. E. (2009). Process systems analysis and control (3rd ed.). McGraw-Hill

CH302N PROCESS EQUIPMENT DESIGN & SIMULATION (1-1-2) 3

Fundamentals of process equipment design, design standards, safety considerations, and ASPEN Plus simulation; design and simulation of heat exchangers, evaporators, condensers, distillation and absorption columns, and pressure vessels; thermodynamic property estimation, VLE, equipment sizing, rating, and hydraulic analysis; simulation of process units, recycle streams, and integrated process flowsheets; troubleshooting, sensitivity analysis, optimization; and a comprehensive mini-project on process design, equipment sizing, simulation, validation, and technical reporting.

Coulson, J. M., & Richardson, J. F. (Eds.). (2000). Chemical engineering (Vol. 6, 4th ed.). Elsevier / Butterworth-Heinemann.
Kern, D. Q. (1997). Process heat transfer (paperback ed.). McGraw-Hill
Jana, A. K. (2012). Process simulation and control using Aspen (paperback ed.). PHI Learning.
Al-Malah, K. I. M. (2016). ASPEN PLUS® chemical engineering applications (paperback ed.). John Wiley & Sons

CH303N CHEMICAL REACTION ENGINEERING PRACTICE (0-1-4) 3

Laboratory experiments on reaction kinetics in batch, CSTR, tubular, and cascade reactors;

residence time distribution (RTD) studies for non-ideal reactors : CSTRs, PFRs, CSTR-PFR combinations and packed beds; catalytic reactor; non-isothermal reactor; Problem-solving sessions on non-Ideal reactors, non-isothermal reactors, fluid-solid non catalytic and catalytic reactors.

Smith, J. M. (1981). Chemical engineering kinetics (3rd ed., international paperback ed.). McGraw-Hill.
Levenspiel, O. (1999). Chemical reaction engineering (3rd ed., paperback ed.). John Wiley & SonsJana, A. K. (2012). Fogler, H. S. (2004). Elements of chemical reaction engineering (3rd ed., international paperback ed.). Prentice-Hall of India.

CH304N PROCESS DYNAMICS AND CONTROL PRACTICE (0-1-4) 3

Laboratory experiments on the dynamic response of first- and second-order systems, interacting and non-interacting processes, and measurement instruments; analysis of P, PI, and PID controller performance using computer-controlled process trainers; development and tuning of temperature and level control systems; demonstration of control valves and sensors; sensor response analysis; and controller design using Ziegler–Nichols and Cohen–Coon tuning methods with Simulink.

Stephanopoulos, G. (1984). Chemical process control: Theory and practice (Vol. 2). Prentice Hall.
Coughanowr, D. R., & LeBlanc, S. E. (2008). Process systems analysis and control (3rd ed.). McGraw-Hill.
Fogler, Bequette, B. W. (2003). Process control: Modelling, design, and simulation. Prentice Hall Professional.

CH397N DESIGN PROJECT (0-0-18) 9

Students, individually or in groups, will undertake an open-ended chemical engineering design project involving process synthesis, equipment design, process simulation, safety, sustainability, and economic evaluation under the supervision of a faculty guide, culminating in a technical report and presentation.

CH398N/ CH448N/ CH498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

CH399N MAJOR PROJECT - I (0-0-18) 9

The students jointly or individually will be assigned an experimental or a theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VI, VII & VIII semester. The students should complete the preliminary literature survey and a part of the work in the VII semester. Their work will be reviewed and evaluated.

CH449N MAJOR PROJECT - II (0-0-18) 9

Extension and completion of Major project -I started in the previous semester (CH399N). Their work will be reviewed and evaluated.

CH499N MAJOR PROJECT - III (0-0-18) 9

Extension and completion of Major project -I and Major project - II started in the previous semesters. Their work will be reviewed and evaluated.

CH350N PROCESS INSTRUMENTATION (3-0-0) 3

Introduction: Temperature measurement, Pressure measurement, Flow measurement, Level measurements Viscosity measurement, Moisture and humidity measurements. Conductivity meter- pH meter, Analytical instruments – Liquid chromatography – HPLC – Mass spectroscopy - Computer aided analysis – process instruments and automatic analysis.

Nakra B.C and Chaudhry K Instrumentation, Measurement and Analysis, Tata McGrow Hill Co., New Delhi, 4th edition 2017.
Liptak B.G, Encyclopaedia of Instrumentation, Vol.I, and supplement Chelton Book Co., New York, 4th edition 2003.
Willard, Merru, Dean and Settle, C.B.S, Instrumental Methods of Analysis, publication, New Delhi,7th edition 1988
R.K. Jain, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi, 12th edition 2004.

CH351N ENERGY TECHNOLOGY (3-0-0) 3

Energy Scenario in India - Conventional/non-conventional renewable non-renewable sources. Principles of efficient use of fuels, energy conservation and auditing. Solid liquid and Gaseous fuels. Combustion, Furnaces. Draught and chimney height. Nuclear Energy - Classification and Components. Unconventional fuels, renewable energy sources.

S. P. Sharma and Chander Mohan, Fuels and Combustion, Tata McGraw-Hill Book Co., New Delhi, India, 1982.
A. K. Shaha, Combustion Engineering and Fuel Technology: Optimum Utilization of Fuels, Oxford & IBH Publishing Co., New Delhi, India, 1974.
J. D. Gilchrist, Fuels, Furnaces and Refractories, 1st ed., Pergamon Press, Oxford, UK, 1977.
R. F. Probstein and R. E. Hicks, Synthetic Fuels, Dover Publications, Mineola, NY, USA, 2006.
M. L. Smith and K. W. Stinson, Fuels and Combustion, McGraw-Hill Book Co., New York, USA, 1952.

CH352N PETROLEUM REFINING PROCESSES (3-0-0) 3

Introduction. Composition and evaluation of properties of crude oil and refinery products. Refining of petroleum. Types of pipes still furnaces used in refineries and their design consideration. Cracking processes. Rebuilding processes. Product treatment processes.

Robert A. Meyers, Hand Book of Petroleum Refining Processes, McGraw Hill Book Co., 4th edition 2016.
Bhasker Rao B.K, Modern Petroleum Refining Processes, Oxford & IBM Publishing Co.,6th edition 2020.

CH400N BIOCHEMICAL ENGINEERING (3-0-0) 3

Introduction to biochemical engineering and its applications, Role of microbes and microbiology in development of biochemical engineering. Types of organisms, their nomenclature. Introduction to medium formulation for microorganisms and types of media used. stoichiometry of biological reactions, Growth kinetics of microorganisms, Bioreactor configurations. yield coefficient and its importance in media development.

Introduction to mass transfer in bioreactors, determination of transfer rates, Enzyme catalysed reactions and kinetics.

Bailey J E, Ollis D.F. Biochemical Engineering Fundamentals, 2nd Edition, McGraw-Hill, USA, 2010
Doran P M, Bioprocess Engineering Principles, Academic Press, 2008 Shuler M L, Kargı F, Bioprocess Engineering, , Prentice Hall PTR, 2017

CH401N INTRODUCTION TO MOLECULAR SIMULATIONS (2-1-0) 3

Introduction and basics of molecular simulations – model systems, interaction potentials, periodic boundaries, minimum image convention, Equations of motion. Elementary statistical mechanics: ensembles, Boltzmann's distribution, and free energy. Measure and control of temperature and stress in molecular systems. Length and time scale limits of simulation methods. Molecular dynamics of simple model fluids such as hard spheres. Structure of a simulation program and introduction to programming methods. Applications in solids, liquids, and biomolecules. Demonstration using LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator).

M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, 2nd ed., Oxford University Press, Oxford, UK, 2017.
D. Frenkel and B. Smit, Understanding Molecular Simulation: From Algorithms to Applications, 2nd ed., Academic Press, San Diego, CA, USA, 2002.
D. C. Rapaport, The Art of Molecular Dynamics Simulation, 2nd ed., Cambridge University Press, Cambridge, UK, 2004.
D. A. McQuarrie, Statistical Mechanics, University Science Books, Sausalito, CA, USA, 2000.

CH402N FUEL CELL ENGINEERING (3-0-0) 3

Overview of Fuel Cells, Classification, Basic chemistry and thermodynamics. Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels. Fuel cell electrochemistry: electrode kinetics. Fuel cell process design: PEM fuel cell components. Fuel cell operating conditions: pressure, temperature, flow rates, humidity. Components of solid-oxide fuel cells. Fuel processing: Direct and indirect internal reforming, steam reformation, CO2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, Impurity removal, renewable fuels for SOFCs.

Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
Barbir F, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.
Subhash C. S and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003

CH450N CHEMICAL PROJECT ENGINEERING (3-0-0) 3

Introduction. Components of Techno-economic feasibility report. Site selection factors, prefeasibility analysis, Capital and operating costs, cashflow statement, project evaluation. project scheduling: Gantt charts, CPM, PERT, network formulation and scheduling, project handover and documentation. Project financing, annual report analysis.

P. Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, 9th ed., McGraw Hill Education (India) Private Limited, New Delhi, India, 2019.
R. Turton, J. A. Shaeiwitz, D. Bhattacharyya, and W. B. Whiting, Analysis, Synthesis, and Design of Chemical Processes, 5th ed., Pearson, Boston, MA, USA, 2018.
V. V. Mahajani and S. M. Mokashi, Chemical Project Economics, 2nd ed., Trinity Press, New Delhi, India, 2015.

CH451N ENERGY CONSERVATION AND MANAGEMENT IN PROCESS INDUSTRIES (3-0-0) 3

Energy Outlook, Energy conservation and its importance, Energy intensive industries, Global industrial energy efficiency benchmarking, Engineering fundamentals related to energy efficiency, Principles on energy management, Energy Audit, Detailed thermodynamic analyses of common unit operations, Opportunities and techniques/methods for energy conservation in equipment and utility systems in process industries, Process synthesis, Thermo-economics, Energy Management Information Systems (EMIS). Software tools for industrial energy efficiency and savings, Case studies on energy conservation and management in process industries

Kenney W F, Energy Conservation in the Process Industries. Academic Press Inc., 1984.
Stepanov V S Analysis of Energy Efficiency of Industrial Processes. 1st Edition, Springer-Verlag, 1993. K. Sankaranarayanan, Efficiency and Sustainability in the Energy and Chemical Industries: Scientific Principles and Case Studies, 3rd ed., CRC Press, Boca Raton, FL, USA, 2024.

Department of Civil Engineering (CE)

Bachelor of Technology in Civil Engineering

Basic Science Courses (BSC)

CY100N	Engineering Chemistry	(3-0-2)4
MA100N	Numerical Methods	(3-0-0)3
MA105N	Probability and Statistics	(3-0-0)3
PH100N	Engineering Physics	(3-0-2)4
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

CS101N	Computer Programming (Python)	(0-0-6)3
DE100N	Design Thinking and Prototyping	(2-0-2)3
UC100N	Data Science and AI	(2-0-2)3
UC101N	Introduction to Engineering	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC)

CE200N	Elements of Surveying	(2-0-2)3
CE201N	Engineering Geology	(2-0-2)3
CE202N	Civil Engineering Materials	(2-0-0)2
CE203N	Civil Engineering Materials Lab	(0-0-2)1
CE204N	Building Construction	(2-0-0)2
CE205N	Building Drawing Lab	(0-0-2)1
WO201N	Mechanics of Solids	(2-1-0)3
WO202N	Mechanics of Fluids	(2-0-0)2
WO203N	Strength of Materials Lab	(0-0-2)1
WO204N	Mechanics of Fluids Lab	(0-0-2)1
CE250N	Highway and Traffic Engineering	(2-1-0)3
CE251N	Soil Mechanics	(2-1-0)3
CE252N	Soil Mechanics Lab	(0-0-2)1
CE253N	Structural Analysis	(2-1-0)3
CE254N	Environmental Engineering	(2-1-0)3
CE255N	Environmental Engineering Lab	(0-0-2)1
CE256N	Design of RCC Structures	(2-1-0)3
WO211N	Water Resources Engineering	(2-0-0)2
CE300N	Estimation Costing and Specifications	(2-1-0)3
CE301N	Matrix and Finite Element Analyses of Structures	(2-1-0)3
CE302N	Applied Soil Engineering	(1-1-0)2
CE303N	Design of Steel Structures	(2-1-0)3
CE304N	Structural Design and Drawing	(1-0-2)2

Dept/Institute Elective Courses (DEC)

CE350N	Design of P.S.C. Structures	(2-1-0)3
CE351N	Probability Methods in Civil Engineering	(2-1-0)3
CE352N	Advanced Structural Analysis	(2-1-0)3
CE353N	Geoinformatics	(2-1-0)3
CE354N	Rock Mechanics	(2-1-0)3
CE355N	Applied Geology	(2-1-0)3
CE356N	Air Pollution and Noise Pollution	(2-1-0)3
CE357N	Computer Aided Design and Applications in Civil Engineering	(2-0-2)3
CE358N	Structural Dynamics and Wind Engineering	(2-1-0)3
CE359N	Finite Element Analysis of Structures	(2-1-0)3
CE360N	Concrete Technology	(2-1-0)3
CE361N	Construction and Project Management	(2-0-2)3
CE362N	Architecture and Town Planning	(2-1-0)3
CE363N	Analysis of Indeterminate Structures	(2-1-0)3
CE364N	Remote Sensing and GIS	(2-1-0)3
CE365N	Advanced Environmental Engineering	(2-1-0)3
WO371N	Open Channel Flow and Sediment Transport	(3-0-0)3
WO372N	Civil Engineering Systems Optimization	(2-1-0)3
CE400N	Applied Rock Engineering	(2-1-0)3
CE401N	Ground Improvement Techniques	(2-1-0)3
CE402N	Oil and Natural Gas Exploration	(2-1-0)3
CE403N	Design of Foundations and Earth Retaining Structures	(2-1-0)3
CE404N	Non-Destructive Testing and Evaluation of Concrete Structures	(2-1-0)3
CE405N	Bridge Engineering	(2-1-0)3
CE406N	Advanced Design of Structures - I	(2-1-0)3
CE407N	Structural Masonry and Alternative Building Technologies	(3-0-0)3
CE408N	Groundwater Development and Management	(2-1-0)3
CE409N	Solid Waste Management	(2-1-0)3
CE410N	Railway, Port and Airport Engineering	(2-1-0)3
CE411N	Modern Methods and Equipment in Construction	(2-1-0)3
WO400N	Geographic Information Systems	(2-0-2)3
WO401N	Satellite Digital Image Analysis	(2-1-0)3
WO402N	Introduction to Geospatial Technologies and Applications	(2-0-2)3
WO421N	Design of Hydraulic Structures	(2-1-0)3
WO422N	Fundamentals of Coastal Engineering	(2-1-0)3
WO423N	Basics of Offshore Engineering	(2-1-0)3
WO424N	Coastal Erosion and its Mitigation	(2-1-0)3
WO445N	Fundamentals of Finite Element Method	(2-1-0)3
CE450N	Slope Stability and Landslides	(2-1-0)3
CE451N	Foundation Engineering - Shallow and Deep	(2-1-0)3
CE452N	Reinforced Soil Structures	(2-1-0)3
CE453N	Geoenvironmental Engineering	(2-1-0)3
CE454N	Mechanics of Unsaturated Soils	(2-1-0)3
CE455N	Advanced Design of Structures - II	(2-1-0)3

CE456N	Elements of earthquake Engineering	(2-1-0)3
CE457N	Geohazard Mitigation	(2-1-0)3
CE458N	Seismoresistant Concrete Structures	(2-1-0)3
CE459N	Disaster Management and Mitigation	(2-1-0)3
CE460N	Environmental Impact Assessment	(2-1-0)3
CE461N	Retrofitting and Rehabilitation of Structures	(2-1-0)3
CE462N	Transportation System Planning	(2-1-0)3
WO473N	Urban Storm Water Management	(2-1-0)3
WO474N	Computational Methods in Hydrology	(2-1-0)3
WO475N	Geophysical Exploration and Identifications	(2-1-0)3
WO477N	Open-Source Virtual Instrumentation	(2-0-2)3
WO478N	Theory of Isotropic Elasticity	(2-0-2)3
WO480N	Civil Engineering Applications of Remotely Operated Systems	(2-0-2)3
WO481N	Remote Sensing of Climate Change	(2-0-2)3
WO482N	GIS Applications in Civil Engineering	(2-1-0)3
WO483N	WebGIS and Mapping for Water Resources and Civil Engineering Applications	(2-0-2)3
WO484N	Introduction to Unmanned Aerial Vehicles and Applications	(2-1-0)3

Internships/Major Project Courses (IPC)

CE398N	Internship - I	(0-0-18)9
CE399N	Major Project - I	(0-0-18)9
CE448N	Internship – II	(0-0-18)9
CE449N	Major Project - II	(0-0-18)9
CE498N	Internship – III	(0-0-18)9
CE499N	Major Project - III	(0-0-18)9

Suggested Plan of Study for B.Tech. in Civil Engineering:

Slot/ Semester	I	II	III	IV	V	VI	VII	VIII
1	PH100N	CY100N	CE200N	CE250N	CE300N	CE398N / CE399N	CE448N / CE449N	CE498N / CE499N
2	MA105N	MA100N	CE201N	CE251N	CE301N	DEC	DEC	DEC
3	CS101N	DE100N	CE202N	CE252N	CE302N	DEC	DEC	DEC
4	UC101N	UC100N	CE203N	CE253N	CE303N	DEC		
5	UC102N	UC103N	CE204N	CE254N	CE304N			
6	PL1XWN/ PL1X9N	PL1YWN/ PL1Y9N	CE205N	CE255N	PL3XWN/ PL3X9N			
7			WO201N	CE256N				
8			WO202N	WO211N				
9			WO203N	PL2YWN/ PL2Y9N				
10			WO204N					
11			PL2XWN/ PL2X9N					

Requirements for B.Tech. in Civil Engineering:

Category of Courses	Minimum Credits to be Earned
Foundation Courses Basic Science Courses (BSC): 20 General Engineering Courses (GEC): 12	32
Programme Core Courses (PCC)	51
Department/Institute Elective Courses (DEC)	21
Internships/Major Project Courses (IPC)	27
Life Skill Courses (LSC)	20
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
As decided by DUGC	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Note: Honors and Minor are additional academic provisions and are not counted as separate components within the six regular B.Tech. course components.

CE200N ELEMENTS OF SURVEYING (2-0-2) 3

Introduction to Surveying - Basic concepts, Errors, accuracy and precision; Tape surveying; Compass surveying; Theodolite traverse - measurement of horizontal and vertical angles, traversing; Levelling; Contouring; Horizontal and Vertical curves; Electronic distance measurements; Total station; Areal photogrammetry, Remote sensing and GIS.

B. C. Punmia, Surveying Vol. I & II – Laxmi Publications, New Delhi.
K. R. Arora, Surveying Vol. I & II – Standard Book House, New Delhi.
S. K. Roy, Fundamentals of Surveying - Prentice Hall of India, New Delhi.

CE201N ENGINEERING GEOLOGY (2-0-2) 3

Introduction to Engineering Geology for Civil Engineers; Minerals - Classification and Significance; Rocks - Origin, Classification and Significance; Geological Structures - Mechanism, Classification and Significance; Rheology of Rocks and their Mechanical Behaviours; Weathering of Rocks and Soil formation; Hydrology and geological work of rivers and oceans; Groundwater and Hydrogeology; Site investigations – Techniques and methods; Natural Hazards - Assessment and Mitigation; Geological Considerations for Foundations, Dams, Reservoirs, Tunnels and Bridges.

Practical Experiments: Identification of important minerals; Identification of important rocks; Interpretation of geological maps and cross-sections; Determining Engineering and Index Properties of Rocks; Determining Dip, strike, and usage of Stereographic Projections; Introduction and overview of different geological software

Subinoy Gangopadhya (2013). Engineering Geology. Oxford University Press.
F. G. Bell (2007). Engineering Geology, Second Edition, Elsevier Butterworth-Heinemann.
FGH Blyth and M H de Freitas (1984). Geology for Engineers, 7th Eds. Elsevier Butterworth-Heinemann.

CE202N CIVIL ENGINEERING MATERIALS (2-0-0) 2

Introduction, Cement - Manufacturing, chemical composition, Hydration of cement, Types of cements Properties of cement, Tests on cement. Stones - Classifications, characteristics, and applications. Aggregate – Classification, Properties, Coarse and fine aggregate for concrete Tests on aggregates, grading of aggregates. Steel - Properties, tests and applications. Concrete - Properties Concrete - specifications, and tests. Types of concrete, Admixtures applications Brick, Tiles- flooring – Manufacture, properties and uses. Tar, Bitumen, Asphalt - Properties and uses. Timber - classifications Timber - properties, seasoning, composites. Paints, Enamels, Varnish - Properties and uses.

Duggal, S.K. (2012), "Building Materials", New Age International Pvt. Ltd., New Delhi, 4th edition.
Gambhir, M. L. and Neha J. (2011), "Building Materials", Tata McGraw-Hill Publishing. Company Ltd, 1st edition.

CE203N CIVIL ENGINEERING MATERIALS LAB (0-0-2) 1

Specific Gravity of Fine Aggregates & Coarse Aggregates - Sieve Analysis of Fine Aggregates & Coarse Aggregates - Bulk Density of Fine Aggregates & Coarse Aggregates - Bulking of Sand - Specific Gravity of Cement - Normal Consistency of Cement - Fineness of Cement - Setting Time of Cement - Soundness of Cement - Compressive Strength of Cement - Compressive Strength of Bricks - Water Absorption of Bricks & Tiles

Duggal, S.K. (2012), "Building Materials", New Age International Pvt. Ltd., New Delhi, 4th Edition.
M.S. Shetty (2005), "Cement Technology, Theory and Practice", S.C. Chand & Co. Ltd.

CE204N BUILDING CONSTRUCTION (2-0-0) 2

Introduction – Components of a building and their roles, Different loads acting on a building; Foundations – Functions, Types; Site Investigation, Sub-soil exploration, Bearing capacity of soil, Design of Footings; Stone Masonry - Random rubble and Ashlar; Brick Masonry – Types of Bricks, Bonds in Brickwork; Lintels – Functions, Types, Loading on Lintels, Design of Lintels; Stairs – Types, Design of stairs; Doors and Windows; Roof – Types, Basic Elements of Pitched Roof, Types of Pitched Roof, Roof Covering Materials, Flat Roof; Modern Construction Methods

Punmia, B. C., Jain, A. K. and Jain, A. K. (2016), "Building Construction" Laxmi Publications Pvt. Ltd.
Rangwala, S. C. (2016), "Building Construction", Charotar Publishing House Pvt. Ltd.
P. N. Khanna, Indian Practical Civil Engineers' Handbook
Basic Construction Materials (https://onlinecourses.nptel.ac.in/noc26_ce56/preview)
Fundamentals of Building Construction (https://onlinecourses.swayam2.ac.in/nou25_ce13/preview)

CE205N BUILDING DRAWING LAB (0-0-2) 1

Introduction – Charts and Drafting equipment, Basic Terminology, Lettering, Conventional Signs and Symbols; Foundations; Brick Masonry; Doors and Windows; Stairs – Proportioning and design, details of reinforcements, plan and elevation of various types of RCC stair cases; Roofs and Trusses – Types of roofs; RCC roof with details of reinforcements; Types of trusses; Functional design of Residential & Public Buildings – Plan, Elevation, Section, Line diagram.

AutoCAD – Introduction; Single room building; Residential Building; Institutional & Public Buildings.

Dr. N. Kumara Swamy, & A. Kameswara Rao, Building Planning and Drawing, Charotar, 2010
Shah M.G. Kalec. M. & Patki SY Building Drawing, Tata McGraw Hill, New Delhi, 2000

CE250N HIGHWAY AND TRAFFIC ENGINEERING (2-1-0) 3

Highway Engineering – Introduction to highway engineering, road classification and highway development; Road Users – Characteristics, factors affecting road user behaviour; Vehicle Performance – Tractive effort, resistances, power and speed relationships; Highway Geometric Design – Introduction, design controls and criteria, Sight Distances, Horizontal Alignment, Vertical Alignment, Coordination of Horizontal and Vertical Alignment; Traffic Engineering – Introduction, Traffic Studies, Design of Intersections and Traffic Signals, Traffic Signs and Road Markings, Principles of Road Safety, Introduction to Smart Mobility; Pavement Engineering – Desirable Properties of Pavement Materials, Design of Flexible Pavements, Design of Rigid Pavements.

Khanna, S. K. and Justo, C. E. G. (2017), Highway Engineering, Nem Chand & Bros.
Kadiyali, L. R. (2013), Principles of Highway Engineering, Khanna Publishers.
Kadiyali, L. R. (2017), Traffic Engineering and Transport Planning, Khanna Publishers.
IRC:35-2015 – Code of Practice for Road Markings
IRC:37-2018 – Guidelines for the Design of Flexible Pavements
IRC:58-2015 – Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
IRC:67-2012 – Code of Practice for Road Signs
IRC:73-2023 – Geometric Design Standards for Non-Urban Roads
IRC:93-1985 – Guidelines on Design and Installation of Road Traffic Signals
IRC: SP:41-1994 – Guidelines for the Design of At-grade Intersections in Rural and Urban Areas
IRC: SP:73-2018 – Manual of Specifications and Standards for Two-Laning of Highways with Paved Shoulders
IRC: SP:84-2019 – Manual of Specifications and Standards for Four-Laning of Highways
IRC: SP:99-2013 – Manual of Specifications and Standards for Expressways
Pavement Materials (Prof. Nikhil Saboo, IIT Roorkee) https://onlinecourses.nptel.ac.in/noc22_ce93/preview

Traffic Engineering (Prof. Bhargab Maitra, IIT Kharagpur)
https://onlinecourses.nptel.ac.in/noc24_ce35/preview

CE251N SOIL MECHANICS (2-1-0) 3

Introduction, Origin, nature and distribution of soils. Clay mineralogy, Soil fabric and structure, three phase system, Index properties, Numerical examples. Soil classification- Indian Standard Classification System; Soil hydraulics, Darcy's Law, Determination of coefficient of permeability; Effect of flow on effective stress; Quick sand condition; Soil compaction- Moisture density relationship, Standard & Modified Proctor Tes; Pore water pressure, effective stress, total stress. Capillarity in soils, Stress distribution in soils; Consolidation – Primary and secondary consolidation, Spring analogy; Computation of settlement, Numerical examples; Terzaghi's theory, Determination of coefficient of consolidation, Numerical examples; Shear strength of soils- State of stress, Mohr Coloumb theory, Relation between shear strength parameters and principle stress. Shear strength measurement- Direct shear test, UCS, Triaxial compression test, vane shear test.

T.W. Lambe and R.V. Whitman "Soil Mechanics", John Wiley & Sons, New York
Gopal Ranjan and A.S.R. Rao "Basic and Applied Soil Mechanics", New Age International Pub.
Geotechnical Engineering Handbook by Braja M. Das
Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri

CE252N SOIL MECHANICS LAB (0-0-2) 1

Identification of soils, Index properties of soils, Soil permeability, Standard compaction test, Coefficient of consolidation, Direct shear test, Unconfined compression test, Triaxial compression test, Vane shear test, CBR test. *T.W. Lambe, Soil Testing for Engineers, John Wiley and Sons, Inc, New York.*

SP36 Part 1 and Part 2 (Latest editions).

CE253N STRUCTURAL ANALYSIS (2-1-0) 3

Conditions of equilibrium, degrees of freedom, determinate and indeterminate structures, Linear and non-linear structural systems; Three-hinged arches, cables and suspension bridges, suspension bridge with three hinged stiffening girders; Moment area method; Conjugate beam method; Theorems of Castigliano, Betti's law, and Maxwell's theorem of reciprocal deflection; Strain energy method; Unit load method; Statically indeterminate structures; Consistent deformation method; Slope deflection method; Influence line diagrams

Devdas Menon (2008), Structural Analysis, Narosa Publishing House, New Delhi
Reddy CS (2017), Basic Structural Analysis, McGraw-Hill, New Delhi

CE254N ENVIRONMENTAL ENGINEERING (2-1-0) 3

Essentials of water engineering systems; Water sources and demand; Water and wastewater quantities and characteristics, online BOD measurement; Water distribution systems, planning and analysis of water distribution systems, and the use of EPANET software for the quantitative and qualitative analysis of water supply networks; Drinking water standards, Central Public Health & Environmental Engineering Organisation (CPHEEO) manual for water supply and treatment, BIS guidelines; Unit operations and processes of water treatment; Design of a water treatment unit; Essentials of wastewater engineering systems; Wastewater collection and house drainage; Central Public Health & Environmental Engineering Organisation (CPHEEO) manual for wastewater treatment; Unit operations and processes of wastewater treatment, biological nutrient removal techniques (BNR); Design of wastewater treatment units; Consent for establishment and operation of STPs from the State pollution control department; Field visit and hands-on experience

H. S. Peavy, D. R. Rowe, G. Tchobanoglous, "Environmental Engineering", McGraw-Hill Publication
Fair & Geyer, "Water Supply and Waste Water Disposal", John Wiley Publications
B.C. Punmia & Ashok Jain, "Water Supply Engineering & Wastewater Engineering", Arihant Publications

CPHEEO Water Supply & Treatment Manual
CPHEEO Sewerage & Sewage Treatment Manual
BIS guidelines
Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts - https://onlinecourses.nptel.ac.in/noc26_ge27/preview (SWAYAM course)

CE255N ENVIRONMENTAL ENGINEERING LAB (0-0-2) 1

pH, Electrical Conductivity, Turbidity; Jar Test: Coagulation; Solids – Suspended, Dissolved, Settleable, and Volatile, Sulphate Content; Alkalinity; Hardness; Dissolved Oxygen (DO), BOD (Biochemical Oxygen Demand); Available Chlorine in Bleaching Powder, Residual Chlorine in Water, Chlorine Demand; Chlorides in Water, Determination of Iron; Ammonical Nitrogen; Phosphate and Other Nutrients in Wastewater; COD (Chemical Oxygen Demand); Bacteriological Quality of Water – Presumptive Test, Confirmation Test, and determination of MPN; Determination of Na, K, Ca, Li, and Ba using flame photometry, Determination of fluoride using the SPADNS colorimetric method and the Ion-Selective Electrode (ISE) method.

Kotaiah B. and Kumaraswamy N, "Environmental Engineering Laboratory Manual", Charitor Publishing House, India.
APHA, "Standard Methods for testing of water and wastewater, 21st Edition, American Public Health Association, Washington, D. C.
BIS-10500: Indian Standards Code for Water
BIS-3025: Indian Standards Code for Testing of Water

CE256N DESIGN OF RCC STRUCTURES (2-1-0) 3

Introduction, Strength properties and behaviour of concrete and reinforcing steel, Basic principles of working stress design – Illustrative examples, Limit state design concepts – Limit states of collapse and serviceability; Design of members subjected to flexure – Singly reinforced sections, Doubly reinforced, Flanged sections; Design for Shear, torsion. Bond strength, detailing requirements, Design of one-way slabs, two-way slabs; Design of columns – axially loaded columns, with uniaxial and biaxial moments. Design of footings – isolated rectangular, square footings

J. N. Bandyopadhyay (2014), Design of Concrete Structures, PHI Learning Pvt Ltd, New Delhi
N Krishna Raju (2013), Design of Reinforced Concrete Structures, CBS Publishers, New Delhi
J K Wight & MacGregor (2011), Reinforced Concrete Mechanics and Design, Prentice Hall, New Jersey
D Darwin, C W Dolan & A H Nilson, (2010) Design of Concrete Structures, McGraw-Hill, Higher Education.

CE300N ESTIMATION COSTING AND SPECIFICATIONS (2-1-0) 3

Introduction to estimation, types of estimates, Measurements, taking out quantities by method of centreline. Taking out quantities by method of long walls and short walls. Typical estimates for residential buildings. Earthwork calculations including hillside roads. Introduction to departmental procedures. Types of contracts, termination, measurement book, and payment to contractors. Tenders, arbitration. Specifications, types and method of drafting. Detailed specifications for selected types of building items. Introduction to analysis of rates. Rate analysis for selected items of works. Introduction to valuation, purpose, forms of value, outgoings, valuation of existing buildings. Valuation of land.

B. N Dutta, "Estimation and Costing in Civil Engineering Theory and Practice", CBS Publishers and Distributors.
M. Chakroborti, "Estimation, Costing and Specifications in Civil Engineering".
S. C. Rangawala, "Valuation of Real Properties", Charotar Publishing House.

CE301N MATRIX AND FINITE ELEMENT ANALYSES OF STRUCTURES (2-1-0) 3

Introduction to Indeterminate Structural Analysis, Moment distribution method - Beams, Frames, Introduction to Matrix method, Element stiffness matrix for spring, bar and truss elements, Stiffness matrix of beam elements, equivalent nodal loads, Assembly procedure, Transformation Analysis of trusses and continuous beams using matrix stiffness method, Introduction to finite element method, discretization, finite elements, steps in finite element analysis, Shape functions, natural coordinates, Numerical integration, One-dimensional finite elements for bars and beams, stiffness matrix and load vector Finite element analysis of bar and trusses, beams and plane frames.

Devdas Menon (2019), Advanced of Structural Analysis, Narosa Publishing
Chandrupatla TR & Belegundu AD (2012), Introduction to Finite Elements in Engineering, 4th Edition, Pearson.
Logan DL (2017), A First Course in the Finite Element Method, 6th Edition, Cengage Learning.
Robert D. Cook, David S. Malkus, Michael E. Plesha, and Robert J. Witt. (2003) Concepts and Applications of Finite Element Analysis, Wiley

CE302N APPLIED SOIL ENGINEERING (1-1-0) 2

Earth pressure- Introduction, Active and Passive states of plastic equilibrium, Rankine's theory, Coefficient of active and Passive Pressure, Effect of surcharge, water table, Layered soil; Problems on the effect of surcharge and water table on active and passive earth pressure, Problems on layered soil; Active and passive earth pressure in c-phi soils+problems; Earth pressure at rest, Coulomb's theory + problem, Culmann's graphical method without and with line load effect; Stability analysis of conventional retaining wall +Problem, Stabililty of slopes – Introduction, Types and causes of failure, Analysis of Infinite slopes in cohesionless soil; Analysis of Infinite slopes in cohesionless soil+ Problem, Analysis of finite slopes by Swedish circle method; Taylor's stability charts and Tables + Problems , Bishop's simplified method; Introduction to geotechnical site investigation, stages of site investigation, planning of exploration program, depth and spacing of boreholes, soil sampling techniques (disturbed and undisturbed samples), field tests – Standard Penetration Test (SPT), Plate Load Test, brief introduction to Cone Penetration Test (CPT); Introduction to shallow foundations, types of footings and applications, general shear, local shear and punching shear failures, Terzaghi's bearing capacity theory, bearing capacity factors, effect of depth and shape of footing; Effect of water table on bearing capacity, net and gross bearing capacity, safe and allowable bearing capacity, problems on bearing capacity of strip, square and circular footings; bearing capacity from SPT and Plate Load Test data, foundation selection criteria based on soil conditions, shallow foundation design considerations, problems on allowable bearing pressure; Introduction to pile foundations, types and functions of piles, load transfer mechanism, ultimate and allowable load carrying capacity of single pile, pile capacity in cohesive and cohesionless soils, pile capacity estimation using SPT data, pile load test, problems; Pile group action and efficiency, block failure concept, bearing capacity of pile groups, problems on pile group capacity

B M Das, "Principles of Geotechnical Engineering", PWS series in Civil Engg.
V. N. S. Murthy, "Soil Mechanics and foundation Engg.", Dhanpat Rai and Sons, New Delhi.
Relevant latest IS Codes.
Gopal Ranjan and ASR Rao "Basic and Applied Soil Mechanics", New Age International

CE303N DESIGN OF STEEL STRUCTURES (2-1-0) 3

Introduction to Limit State Method and Working Stress Method of design, Steel as a material and properties of steel, Symmetry, geometrical properties and stability, Member design – overview, Design of tension members, compression members, flexural members, beam-columns and plate girders, Effective length calculations, bolted and welded connections, Introduction to detailing

N. Subramanian, "Design of Steel Structures: Limit State Method", Oxford University Press.
N.S. Trahair, M.A. Bradford, David Nethercot and Leroy Gardner, "The Behaviour and Design of Steel Structures to EC3", CRC Press.

CE304N STRUCTURAL DESIGN AND DRAWING (1-0-2) 2

Analysis, design and drawing of beams, continuous beams, one-way slabs and two-way slabs using CAE and CAD packages. Design of columns under axial compression, axial and bending, axial and bi-axial bending using CAE and CAD packages. Analysis and design of portal frames, space frames. Analysis and design of stairs. Introduction to steel detailing and symbols, Detailing of rolled sections and built-up sections using software, Analysing a structure having various structural elements in local and global coordinates, Design of steel columns, beams, beam-columns, base-plate, and connections using software output, Introduction to splice plate and gusset plate design, Interpreting the design to detailing (strength design) and detailing to design (capacity evaluation)

B. C. Punmia (2021), "R.C.C. Designs", Laxmi Publications, New Delhi.
N. Subramanian, "Design of Steel Structures: Limit State Method", Oxford University Press

CE350N DESIGN OF P.S.C STRUCTURES (2-1-0) 3

Basic principles of pre-stressing; stresses in concrete due to pre-stress and loads; prediction of long term and short-term deflections; limit state of collapse in flexure and shear - Limit state of serviceability; transmission length; anchorage zone stresses; design of end-block; design of pre and post-tensioned beams; analysis of continuous beams; concordant cable profiles; analysis of composite beams; determination of stress distribution in a composite sections.

N. Krishna Raju, Pre-stressed concrete, Tata-McGraw Hill, New Delhi.
T. Y. Lin and N. H. Burns, Design of pre-stressed concrete structures, John Wiley and Sons, New York.

CE351N PROBABILITY METHODS IN CIVIL ENGINEERING (2-1-0) 3

Role of probability in civil engineering problems; Definition of basic random events; Application of set theory in definition of composite event operations; Probability of events and definition of probability axioms; Random variables; Probability definitions; Moments and expectations; Functions of random variables; Common probability models; Statistics and sampling; Regression and correlation analyses; Estimation of distribution parameters from statistics; Hypothesis testing and significance; Bayesian updating of distributions; Uncertainty quantification; Probabilistic analysis; Methods of structural reliability; Applications to design of civil engineering systems.

H-S. Ang & W.H. Tang, Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, Wiley, 2006
A. Haldar & S. Mahadevan, Probability, Reliability, and Statistical Methods in Engineering Design, Wiley, 1999

CE352N ADVANCED STRUCTURAL ANALYSIS (2-1-0) 3

Influence line diagrams, Analysis of Beams of non-uniform cross-section. Unsymmetrical bending of beams. Analysis of beams curved in plan.

S. Borg, J. Gennaro, Advanced Structural Analysis.
Devdas Menon, Advanced Structural Analysis,

CE353N GEOINFORMATICS (2-1-0) 3

Introduction to Remote Sensing and Geographic Information Systems (GIS), types of sensors and platforms, Remote sensing techniques, spatial data analysis and applications, principles of Global Positioning System (GPS), accuracy assessment, Use of GIS and RS techniques in resources management, natural hazards, environmental monitoring, optimal site selection, rural and urban development.

Basudev Bhatta, Remote sensing and GIS, II Edition, Oxford Publishing House, 2016.
Burrough and Mc Dennell, principles of Geographical information systems, Oxford University Press.

George Jeoseph, Fundamentals of Remote Sensing, II Edition, Universal Press, 2017.
Lillesand, Thomas and Kiefer, Remote Sensing and image interpretation, John Wiley and Sons.

CE354N ROCK MECHANICS (2-1-0) 3

Introduction to rock mechanics, Engineering classification of rocks, Engineering properties of intact rocks, Determination of in situ properties - shear strength, deformation, in situ stress, strength of jointed rocks, application to rock slopes, rock blasting, ground improvement techniques in rocks and bearing capacity, A bird's-eye view of relevant software.

Jaegar and Cook, Foundation of rock masses.
Goodman, Introduction to rock mechanics, Wiley international

CE355N APPLIED GEOLOGY (2-1-0) 3

Introduction, interior of the earth, Geological hazards, Natural resources; Minerals, rocks, water, soil; Engineering properties of rocks, Structural geology, stratigraphy, Hydrogeology; artificial recharge structures, rain water harvesting, ground water exploration, geophysical exploration, Remote sensing and GIS applications. Economic Geology, process of formation of mineral deposits, ore genesis, ore dressing, Indian mineral deposits, Environmental geology, Application of geology in Civil Engg. projects like Dams, tunnels, bridges etc.,

Blyth, F.G.H & De Freitas M.H., Engineering Geology, ELBS, 7thEdition, 1984.
Robert F. Legget, Geology and Engineering, McGraw Hill

CE356N AIR POLLUTION AND NOISE POLLUTION (2-1-0) 3

Natural and man-made air pollution, sources, effects, control, Noise pollution - sources, measurement, mitigation

Wark Kenneth and Warner C.F., Air Pollution its Origin and Control, Harper and Row, Publ.
Sincero A.P. and Sincero G.A. Environmental Engineering. Prentice Hall

CE357N COMPUTER AIDED DESIGN AND APPLICATIONS IN CIVIL ENGINEERING (2-0-2) 3

Programming concepts: Design of beams, slabs and columns by limit state method, solving problems in civil engineering. Introduction to software packages relevant to civil engineering. Applications of Artificial Intelligence, Machine learning in Civil Engineering.

E. Balaguruswamy, Object oriented programming in C++, McGraw Hill Publishers
V.L. Shah, Computer aided design in reinforced concrete, Structures publishers.

CE358N STRUCTURAL DYNAMICS AND WIND ENGINEERING (2-1-0) 3

Vibration of SDOF systems - Free and Forced vibrations, effect of damping, response spectrum, MDOF systems - Natural frequencies and modes, Eigenvalue problem, mode superposition method, Wind effects- Mean Wind speed, turbulence, spectrum of turbulence, Aerodynamic instabilities, Aerodynamic damping, Along - wind and Across - wind responses.

Clough and Penzien, Dynamics of Structures, McGraw Hill, New York.
J.W. Simth, Vibration of Structures, Chapman and Hall Ltd., New York.
Scanlan and Sachi, Wind Engineering

CE359N FINITE ELEMENT ANALYSIS OF STRUCTURES (2-1-0) 3

Types of elements - Boundary value problems – Weighted residual method, Galerkin, weak form for bars and beams, Approximate methods - Principles and steps in Finite Element Analysis - Generalized and natural co-ordinates - Analysis of 2D Trusses, beams, and Plane frames. Introduction to continuum problems - Triangular and quadrilateral elements for plane stress problems - Numerical Integration.

R. Chandrupatla & Ashok D. Belegundu, Introduction to Finite Elements in Engg. - Prentice Hall.
O. C. Zienkiewicz and K Morgan, Finite Elements & Approximation, John Wiley & Sons.

CE360N CONCRETE TECHNOLOGY (2-1-0) 3

Concrete making materials - Manufacture of Cements, types of cements and aggregates, properties and testing, Water, admixtures. Fresh concrete, workability, Compaction, Curing. Strength of Concrete, elasticity, shrinkage and creep. Durability of Concrete. Testing of hardened concrete, destructive and non-destructive testing methods, Concrete mix design, Quality Control and acceptance Criteria. Special Concretes, Concrete chemicals.

A.M. Neville, Properties of Concrete, The English Language Book Society and Pitman Publishing Co. London, U.K.
M.S. Shetty, Concrete Technology - Theory and Practice, S. Chand & Co. Ltd., New Delhi

CE361N CONSTRUCTION AND PROJECT MANAGEMENT (2-0-2) 3

Introduction: Project forms, management objectives and functions; organizational chart of a construction company; manager's duties and responsibilities; public relations; Leadership and teamwork; ethics, morale, delegation, and accountability. Planning, Scheduling and Project Management: Planning stages, construction schedules, project specification, monitoring and evaluation; Bar-chart, CPM, PERT, network formulation and time computation, Time vs Cost Trade-off, Crashing. Resource Management: Resources, resource allocation, resource smoothing and levelling, Man-power planning, training, recruitment, motivation, welfare measures and safety laws; Inventory Management: ABC analysis, VED analysis, EOQ, JIT; Quality Management: QA, QC, TQM

Practice: MS-Project, Primavera
P.P. Dharwadkar, Management in Construction Industry, Oxford IBH, New Delhi
J.O. Brien, Construction Management, McGraw-Hill
J.M. Antill& R.W. Woodhead, Critical Path Methods in Construction, Wiley
B.C. Punmia & K.K. Khandelwal, Project Planning and Control with PERT and CPM, PWD Codes A and D
Kumar Neeraj Jha, Construction Project Management: Theory and Practice, Pearson

CE362N ARCHITECTURE AND TOWN PLANNING (2-1-0) 3

Town Planning and Architecture: An overview of ancient human settlements; Indus Valley, Manasura's classification of villages, Dantaka Village, Slums, Housing Bye-laws, Neighbourhood units, objectives and principles of town planning, Master-Plan, Zoning, Aesthetics and Principles of Architectural Composition.

S.C. Rangawala, Principles of Town Planning
Sir. Banister Fletcher, Comparative Architecture
Talbot Hamlin, Forms and Functions of Twentieth Century Architecture; Vol II

CE363N ANALYSIS OF INDETERMINATE STRUCTURES (2-1-0) 3

Analysis of statically indeterminate Structures, Moment distribution Method, Kani's Method, Matrix method: introduction to flexibility and stiffness methods, two hinged arches, influence lines for indeterminate beams

and arches, analysis of multistore frames by approximate methods, substitute frame, portal and cantilever methods, plastic analysis of simple beams and portal frames

S.P. Timoshenko, Theory of structures
M.B. Kanchi, Matrix method of structural analysis

CE364N REMOTE SENSING AND GIS (2-1-0) 3

History and introduction, principles of Remote Sensing satellites and sensors, different types of sensors and platforms, resolution concepts, spectral reflectance curves, spectral indices, thermal infrared remote sensing, passive microwave radiometry, active microwave remote sensing; Introduction to Geographic Information Systems (GIS), spatial data sources and models, spatial data analysis and applications, principles of Global Positioning System (GPS), accuracy assessment in GIS and GPS, applications of Remote Sensing, GIS and GPS in resources management, natural hazards like landslide, flood and seismic hazard, environmental monitoring and change detection, optimal site selection, rural and urban development.

Basudev Bhatta, Remote sensing and GIS, II Edition, Oxford Publishing House, 2016.
Burrough and Mc Dennell, principles of Geographical information systems, Oxford University Press.
George Jeoseph, Fundamentals of Remote Sensing, II Edition, Universal Press, 2017.
Hassan A. Karimi, Handbook of Research in Geoinformatics, Information Science Reference, 2017.
Lillesand, Thomas and Kiefer, Remote Sensing and image interpretation, John Wiley and Sons

CE365N ADVANCED ENVIRONMENTAL ENGINEERING (2-1-0) 3

Water-pollution control: Effluent standards. Disposal of wastewater. Stream sanitation. Water quality indices; Solid waste management: Characteristics, treatment disposal; Air Pollution Control: Sources and Characteristics, effects, Control; Noise Pollution Control, measurement & analysis; Hazardous solid waste: Classified wastes, Disposal of hospital wastes; EIA: Introduction, case studies.

Metcalf & Eddy, Waste Water Engineering Treatment, Disposal & Reuse, Tata McGraw Hill Publishers Sincero & Sincero, Environmental Engineering, Prentice Hall Inc.

CE398N/ CE448N/ CE498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

CE399N MAJOR PROJECT - I (0-0-18) 9

The students jointly or individually will be assigned an experimental or a theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VI, VII & VIII semester. The students should complete the preliminary literature survey and a part of the work in the VII semester. Their work will be reviewed and evaluated.

CE449N MAJOR PROJECT - II (0-0-18) 9

CE499N MAJOR PROJECT - III (0-0-18) 9

CE400N APPLIED ROCK ENGINEERING (2-1-0) 3

Introduction: Rock mass failure mechanism and its influencing factors –IS Standards in Rock Engineering – Types of excavations in rocks: - Tunnels and Slopes – Design methods in massive, stratified and jointed rock mass – Tunneling: Methods of Tunneling – Excavation of large tunnels, hazards in tunnelling –Rock Slope: Mechanics of rock slope failure- Factor affecting rock slope stability – slope stability – analysis and rating – Rock reinforcement techniques – Monitoring of rock deformation in slope and underground space

Engineering rock mechanics: Introduction to principles –J.A. Hudson; J.P. Harrison, 1997.
Engineering rock mass classification – Tunneling, Foundations and Landslides R K Goel, Bhawani Singh, 2011.
Support of Underground Excavations in Hard Rock – Hoek, Kaiser, Bawden, 2000.
Rock Slope Engineering (IV Eds) – D.C. Wyllie; C.W. Mah, 2004

CE401N GROUND IMPROVEMENT TECHNIQUES (2-1-0) 3

Need and Objectives, Mechanical Modification-Compaction control, Vibro flotation, Hydraulic Modification-Dewatering methods, Electro-Osmosis, Vertical drains, Physical and chemical modification-grouting, shortcreting, ground freezing. Modification by inclusions and Confinement. Stone columns, lime columns, Sand drains and Compaction piles.

M.R. Hausmann (1990) Engineering Principles of Ground Modifications, McGraw Hill Publishing Co.
Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi.

CE402N OIL AND NATURAL GAS EXPLORATION (2-1-0) 3

Introduction to petroleum and natural gas, Geological factors, origin and accumulation of oil and gas resources, exploration of oil and natural gas deposits, reservoir Engineering; Drilling and Production Engineering; Distribution of oil and gas resources

A. I. Levorsen, 1967, Geology of Petroleum
Azar J J, Samuel G R, 2007, Drilling Engineering. Pennwell Corporation.
Edwin S. Robinson and CahitCoruh, 1988, Basic Exploration Geophysics, John Wiley and Sons.

CE403N DESIGN OF FOUNDATIONS AND EARTH RETAINING STRUCTURES (2-1-0) 3

Loads for foundation design, Depth of foundation, proportioning of footings, Geotechnical and structural design of isolated, combined and raft foundations. Design of piles and pile cap. Design of cantilever, counterfort.

Swami Saran, Design of Substructures, Oxford and IBH Publishers.
J.E. Bowles, Analysis & Design of Foundations, Mc Graw Hill.
Relevant IS Codes.

CE404N NON-DESTRUCTIVE TESTING AND EVALUATION OF CONCRETE STRUCTURES (2-1-0) 3

Fundamentals and basic concepts of Non Destructive Testing and Evaluation. Principle and applications of different Non Destructive Evaluation tools viz., Ultrasonics, radiography, electromagnetic methods, acoustic emission, thermography for testing and evaluation of concrete structures.

Guidebook on non-destructive testing of concrete structures-International Atomic Energy Agency, Vienna, 2002
Non-destructive Evaluation –Theory Techniques and Applications by P.J Shull Marcell Decker Inc., NY 2002

Non-destructive Testing and Evaluation of Materials Tata McGraw Hill Education Private Limited Second Edition 2011
Acoustic Emission testing –Basic for Research-Applications in Civil Engineering Chriastan U Grosse, Masayasu Ohtsu , Springer:2008

CE405N BRIDGE ENGINEERING (2-1-0) 3

Site investigation and planning, hydrology, Standards of loading for highway, Culverts, bridge superstructures, Design of R.C.C. beam and slab bridges, load distribution methods, Bearings, Design of bridge substructures, Design principles of prestressed concrete, steel and composite bridges, Introduction to cable stayed and suspension bridges, flyovers, temporary and movable bridges, construction and maintenance of bridges and flyovers.

D. J. Victor, Essentials of Bridge Engineering, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
N. Krishna Raju, Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
IRC 6, IRC-112

CE406N ADVANCED DESIGN OF STRUCTURES - I (2-1-0) 3

Design of R.C. flat slabs, continuous beams and portal frames, redistribution of moments. Yield line analysis of slabs, Deep beams, Curved beams, Elevated water tanks and supporting structures, Chimneys, Silos and Bunkers.

N. Krishna Raju, Advanced Reinforced Concrete Design, C.B.S. Publishers and Distributors, Delhi.
P.C. Varghese, Advanced Reinforced Concrete Design, Prentice - Hall of India, Pvt. Ltd., New Delhi.

CE407N STRUCTURAL MASONRY AND ALTERNATIVE BUILDING TECHNOLOGIES (3-0-0) 3

Stresses in masonry, Strength of masonry in compression, Brick – Mortar Bond strength, Elastic properties of masonry materials and masonry, Design of masonry walls under vertical gravity loads; Analysis and design of masonry domes and vaults, Construction of masonry domes and vaults, Problem of lateral thrust; Concepts in alternate roofing systems, Filler slab roofs, Composite beam and panel roofs; Alternatives to wall construction, Rammed earth, Stabilized mud blocks; Energy in building materials and buildings, environmental friendly and cost effective building technologies.

Hendry, A. W., Sinha, B. P., and Davies S. R., Design of Masonry Structures, 3rd edition, E & FN Spon 2004.
Drysdale, R. G., and Hamid, A. A., Masonry Structures: Behavior and Design,4th edition, The Masonry Society, 2018
Jagadish, K. S., Venkatarama Reddy, B. V., and Nanjunda Rao, K. S., Alternative Building Materials and Technologies, Second edition, New Age International Publishers, 2018
IS: 1905 – 1987, Code of Practice for Structural Use of Unreinforced Masonry, Third Revision, Bureau of Indian Standards, (Reaffirmed 2002)

CE408N GROUND WATER DEVELOPMENT AND MANAGEMENT (2-1-0) 3

Hydrological cycle, Hydrological properties of rocks, Distribution of ground water, Ground water movement-Darcy's law, Flow nets, Aquifer parameters, Parameter estimation, pump test and recovery test-Thei's, Theim's, Jacob's equations, Ground water exploration-Geophysical techniques RS, GIS, GPS, Construction of wells, Springs, Ground water recharge, Rain Water harvesting, Water conservation techniques, Ground water quality, Ground water pollution, Environmental issues, Ground water buget, Ground water management, Ground water legislation.

Todd D. K, Ground water hydrology, 3rd edition, Wiley, 2008.
Walton, W. C., Ground water resource evaluation. McGraw Hill, 1970. Raghunath, H. M, Ground water, New Age International, 3rd edition, 1998.

Karanth, K. Groundwater Assessment and Management, Tata McGraw Hill, 2007.

CE409N SOLID WASTE MANAGEMENT (2-1-0) 3

Characterization of Municipal wastes, Waste Collection, Disposal and Management-Laws and guidelines, Utilization of municipal wastes for bio-gasification and manure, landfill, Recent technological advances in composting and thermal gasification, Utilization and management of non-hazardous and hazardous waste, Case studies.

George Tchobanoglous, Frank Kreith, Handbook of Solid Waste Management, McGraw-Hill, 2002. CPHEEO, Manual on Solid Waste Management, 2000.
Asian Productivity Organization Report on Solid-Waste Management: Issues and Challengesin Asia, Environmental Management Centre, 2005
Thomas H. Christensen, Solid Waste Technology& Management: Volume 1 & 2, A John Wiley& Sons, 2010
Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans. Hazardous Waste Management, Waveland Press Inc., 2010

CE410N RAILWAY, PORT, AND AIRPORT ENGINEERING (2-1-0) 3

Transportation Modes; Role of Transportation in Sustainable Development. Railway Engineering: Introduction to Indian Railways; Track Structure and Components; Curves and Turnouts; Emerging Track Technology Items; Railway Tunnels; and High-Speed Track. Ports and Harbour Engineering: Introduction to Indian Maritime Sector; Site Investigation; Geotechnical Aspects; Loading; General Design Considerations; Layout and Functional Requirements. Airport Engineering: Introduction to Civil Aviation; Airport Planning - Aircraft Characteristics, Airport Planning Studies, and Forecasting for Airport Planning; Airport Design - Runway and Taxiway Geometric Design, Design of Airport Drainage. Introduction to Airport Airside Capacity and Delay.

Mundrey, J S. 2009. Railway Track Engineering. 4th ed. McGraw Hill Education (India) Private Limited. https://www.accessengineeringlibrary.com/content/book/9780070680128
Satish, C., Agarwal, M. M. 2013. Railway Engineering. India: Oxford University Press.
Indian Railways Permanent Way Manual (Latest Version)
CODE OF PRACTICE FOR PLANNING AND DESIGN OF PORTS AND HARBOURS (PART 1, 2, 3, 4, and 5), Bureau of Indian Standards, New Delhi. (Latest Versions)
Thoresen, C. A. (2014). Port Designer's Handbook. United Kingdom: Thomas Telford.
Horonjeff, Robert, Francis X. McKelvey, William J. Sproule, and Seth B. Young. 2010. Planning and Design of Airports. 5th ed. New York: McGraw-Hill Education.
https://www.accessengineeringlibrary.com/content/book/9780071446419
Young, Seth B., and Alexander T. Wells. 2019. Airport Planning & Management. 7th ed. New York: McGraw-Hill Education. https://www.accessengineeringlibrary.com/content/book/9781260143324

CE411N MODERN METHODS AND EQUIPMENT IN CONSTRUCTION (2-1-0) 3

Drilling and Blasting techniques for foundation; Mechanized methods of concrete works; Precast technology; Prefabrication Techniques and Modular construction; Concepts in alternate roofing systems, Filler slab roofs, Composite beam and panel roofs; Alternatives to wall construction, Rammed earth, Stabilized mud blocks;

Machinery for construction, earth movers and hauling costs, factors affecting purchase, rent, and lease of equipment, and cost-benefit estimation. Other equipment – Hoisting, Conveying, Concreting, Aggregate Production, Pile driving, and Dewatering.

Jagadish, K. S., Venkatarama Reddy, B. V., and Nanjunda Rao, K. S., Alternative Building Materials and Technologies, Second edition, New Age International Publishers, 2018
Mahesh Varma, "Construction Equipment and its Planning and Applications", 5th Edition, Metropolitan Book Co. Publishers, 2005.

CE450N SLOPE STABILITY AND LANDSLIDES (2-1-0) 3

Introduction, Classification of slopes and landslides, Causes of instability, Factors influencing slope stability and landslides, Mechanics of slope stability, Stability analysis – Soil slopes: Bishop's modified method, Janbu's method, Morgenstern and Price, Spencer's method considering the influence of groundwater and seismic forces, Stability analysis – Rock slopes: Planar failure, wedge failure, circular failure, toppling failure, considering the influence of groundwater and seismic forces. Landslide hazards and risks analysis: Hazards associated with various types of landslides based on their volume and velocity, activity, and runout from the landslide inventories and case studies. Landslide susceptibility evaluation and mitigation strategies, Case studies.

Murthy, V.N.S. (2002) Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press.
Cheng YM and Lau CK (2014) Slope Stability and Analysis and Stabilization, CRC Press, Taylor and Francis Group.
Chowdhury R and Bhattacharya G (2010) Geotechnical Slope Analysis, CRC Press.

CE451N FOUNDATION ENGINEERING – SHALLOW AND DEEP (2-1-0) 3

Introduction, contact pressure distribution, Methods of estimating bearing capacity of footings and rafts, Foundations under eccentric and inclined loading, Foundations on slope, Foundations with tilted base, Skirt Foundation, Settlement of footings and rafts, Concept of Beams on Elastic Foundation, proportioning of foundations (field test data, IS codes),

Pile foundations - Methods of estimating load transfer of piles, Settlement of pile group, laterally loaded piles, Uplift capacity of piles, combined pile raft foundations.

IS codes, field case studies, and hands-on problem-solving exercises.
Murthy, V.N.S. (2016) Advanced Foundation Engineering: Geotechnical Engineering Series, CBS Publishers & Distributors Pvt. Ltd.
Budhu, M. (2010) Soil Mechanics and Foundations, John Wiley & Sons.
Kaniraj SR (2018) Design Aids in Soil Mechanics and Foundation Engineering, McGraw Hill Education (India) Pvt. Ltd.

CE452N REINFORCED SOIL STRUCTURES (2-1-0) 3

Overview of the concept of soil reinforcement, Types and properties of reinforcing materials - including geotextiles, geogrids, metal strips, and geocells, along with their interaction with various soil types, Mechanics of reinforced soil - focusing on the improvement in strength, stability, and deformation behavior due to reinforcement, Design and analysis of mechanically stabilized earth (MSE) walls, reinforced soil slopes, and embankments on soft ground, Construction methods, Bearing capacity improvement with reinforcement layers, seismic behavior of reinforced systems, Case studies

Saran S (2013) Reinforced Soil and its Engineering Applications, IK International Publishing House Pvt. Ltd.
Sivakumar Babu GL (2013) An Introduction to Soil Reinforcement and Geosynthetics, Universities Press (India) Pvt. Ltd.
Shukla SK and Yin JH (2006) Fundamentals of Geosynthetic Engineering, Taylor and Francis, London, UK
Koerner RM (2012) Designing with Geosynthetics, Person Prentic Hall

CE453N GEOENVIRONMENTAL ENGINEERING (2-1-0) 3

Introduction and concepts of Geoenvironmental Engineering. Sources & Impact of Contamination, Solid Waste Generation and Disposal, Principles of Landfilling, Covers and liners for landfills – material aspects and stability considerations. Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailings ponds, and in rocks. Subsurface Contamination and Contaminant Transport.

Sarsby, R., Environmental Geotechnics, Thomas Telford, 2000. 4.
Bagchi, A., Design, construction and monitoring of landfills, Wiley Interscience, 1994
Datta, M., Waste disposal in Engineered landfills, Narosa Publishers, 1998. 6.
Vick, S.G., Planning, analysis and design of tailings dams, John Wiley & Sons, 1970 8.

CE454N MECHANICS OF UNSATURATED SOILS (2-1-0) 3

Nature and genesis of unsaturated soils: Introduction to phase properties and relations, Shear strength of unsaturated soil, extended Mohr-Coulomb criterion, shear strength and pore pressure parameters, measurements of shear strength parameters; Flow of water in unsaturated soils: Soil-water characteristic curve (SWCC), permeability and hydraulic conductivity function, direct and indirect measurements of SWCC and hydraulic conductivity function. One-dimensional consolidation and swelling for unsaturated soils; A bird's-eye view of relevant software.

D. G. Fredlund & H. Rahardjo Soil Mechanics for Unsaturated Soils, John Wiley & Sons, Inc.
Ning Lu, William J. Likos Unsaturated Soil Mechanics Wiley Publications.

CE455N ADVANCED DESIGN OF STRUCTURES - II (2-1-0) 3

R. C. domes and shell roofs, membrane and beam method of analysis, Multistore building systems; Grid floors, Composite steel and in-situ concrete beams & slabs. Communication and transmission line steel towers.

P. Dayaratnam, Design of Reinforced concrete structures, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
P. Dayaratnam, Design of Steel Structures, A.H. Wheeler & Co. Ltd. Allahabad.
N. Krishna Raju, Advanced Reinforced Concrete Design, C.B.S. Pub. and Distributors, New Delhi.

CE456N ELEMENTS OF EARTHQUAKE ENGINEERING (2-1-0) 3

Engineering seismology - Plate tectonics, Earthquake mechanism, Seismic zoning map of India, seismic waves, earthquake magnitude and intensity, seismic vulnerability, hazard and risk, Introduction to the theory of vibrations - simple SDOF systems, response spectra, Performance of structures, Lessons from past earthquakes, causes of failure and damage Aseismic design of structures - Philosophy & Principles of earthquake resistant design, building forms and architectural design concepts, Introduction to seismic codes, Calculation of equivalent static earthquake forces. Restoration and retrofitting of existing structures.

A. K. Chopra, Dynamics of Structures, Prentice Hall, 2002 IIT Kanpur,
Earthquake Tips, www.nicee.org

CE457N GEOHAZARD MITIGATION (2-1-0) 3

Introduction to Geo-Disaster, Geo-disasters caused by earthquake, flood, excess rainfall and tsunami, Effects, reasons and mechanisms of the damage triggered by geo-disasters, Various techniques and countermeasures for mitigation and prevention, Damage caused by earthquake and its mitigation, Seismic earth pressure theory, Hydro-dynamic pressure, Liquefaction, Earth pressure due to liquefaction, Liquefaction-induced damage and countermeasures, Disasters due to flood and countermeasures, Coastal Geo-Disaster and mitigation, Relevant Codes and Guidelines from various countries, World-famous case studies.

Steven L. Kramer, Geotechnical Earthquake Engineering, Prentice Hall.
Gopal Ranjan and A.S.R Rao, Basic and Applied Soil Mechanics, New Age International Publication.
B.M. Das, Advanced Soil Mechanics, CRC Press.

CE458N SEISMORESISTANT CONCRETE STRUCTURES (2-1-0) 3

Introduction to dynamic response of structures- Dynamic equilibrium, SDOF and MDOF. Earthquake ground motion and response spectra- Characteristics of ground motion, earthquake response spectra. Seismoresistant architecture, IS 1893(Part1):2002 codal provisions, Simplified modal response spectrum

analysis Example problems. Earthquake resistant design of RC elements, Shear walls - Response of concrete and steel to monotonic cyclic loading, Codal provisions of IS 13920:1993. Design example of a multi-storey building. Seismic retrofitting strategies – considerations, classification, case studies. (IS 13935:1993) Base isolation-Isolation system components, Isolator design procedures. (Mini project on analysis and design of a multi storey building)

The Seismic Design Handbook., Farzad Naeim, International code council, Kluwar Academic publishers (USA), 2001
George. G. Penelis and Andreas J. Kappos, Earthquake resistant concrete structures, E & FN Spon Chapman, Hall London, 1997
Farzad Naeim and James M Kelley, Design of seismic isolated structures, John Wiley and sons Inc. 1999
IS codes: IS 1893(Part1):2002, IS 13920:1993, IS 13935:1993
A. K. Chopra, Dynamics of structures - Theory and applications to earthquake engineering, Pearson Education, 2001
B. Pankaj Agarwal, Manish Shrikhande Earthquake Resistant Design of Structures, Prentice- Hall India, 2006

CE459N DISASTER MANAGEMENT AND MITIGATION (2-1-0) 3

Concepts of disaster, Types of disasters - natural and manmade: Cyclone, flood, landslide, land subsidence, fire and earthquake, tsunami, coastal erosion, river erosion, chemical spills, nuclear disasters, mine disasters etc., Psychological and Social Dimensions in Disasters, Trauma and Stress. Techniques of monitoring and design against disasters, forecasting and early warning, communications & IT Tools, disaster risk reduction through prevention, preparedness, mitigation, response, recovery, rehabilitation and reconstruction, Management issues related to disaster, national Policy on disaster management, legislative responsibilities, mitigation through capacity building, disaster mapping, assessment, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation, Participation by voluntary Agencies & Community at various stages of disaster management, disaster related infrastructure development.

http://ndma.gov.in/ (Home page of National Disaster Management Authority).
http://www.ndmindia.nic.in/ (National Disaster Management in India, Ministry of Home Affairs).
National Disaster Management Plan 2018. National Disaster Management Authority, Ministry of Home Affairs, Government of India.
Tushar Bhattacharya, 2012. Disaster Science and Management. Tata McGraw Hill, New Delhi. ISBN (13): 978-1-25-900736-1, ISBN (10): 1-25-900736-7
Asian Development Bank, 2008. Disaster Management: a Disaster Manager's Handbook ISBN 978-971-561-006-3
Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation.

CE460N ENVIRONMENTAL IMPACT ASSESSMENT (2-1-0) 3

Introduction of EIA - Environmental impact Statement (EIS) and Environmental Impact Analysis (EIA) – Meaning and objective of EIA, Environmental Impact Prediction - Planning and Management of Impact Studies - ISO 14000 Series - Environmental monitoring and mitigation measures.

Canter, R.L., Environmental Impact Assessment, McGraw Hill Inc.
John G. Rau and David C. Wooten (Ed)., Environmental Impact Analysis Handbook, McGraw Hill Book,1980.
Peter Wathern (Ed)., Environmental Impact Assessment, Theory and Practice, Unwin Hyman Ltd., London, 1988.
Munn, R.E., (Ed)., Environmental Impact Assessment, Principles and Procedures, Published on behalf of Scope, Unwin Brothers Ltd., Surrey, London, 1979.

CE461N RETROFITTING AND REHABILITATION OF STRUCTURES (2-1-0) 3

Introduction, Causes of Deterioration, Deterioration process, Planning, Investigation and diagnosis, Assessment of distress structures, Assessment procedure for evaluation of structures and demolition procedures, Testing techniques, Interpretation of results, Repair and renovation Repair materials, techniques, Surface coatings, Protection, Seismic retrofitting.

Allen, R.T.L. and Edwards, S.C., 'The repair of concrete structures'
Key, T., 'Assessment and renovation of concrete structures'
Emmons, P.H., 'Concrete repair and maintenance illustrated'

CE462N TRANSPORTATION SYSTEM PLANNING (2-1-0) 3

Introduction-Transportation Modes, Urban and Intelligent Transportation Systems. Transportation Planning Background, the historical development of transportation systems in India, development of formal transportation planning process, planning studies and methods, and planning issues. Travel-Demand Forecasting-Background, trip generation, trip distribution, mode choice, trip assignment, trip behaviour of individuals and households. Transportation Impact-Traffic impact studies, Parking studies, Air pollution, Noise Pollution, Energy consumption, and introduction to the latest developments in urban mobility and technologies

S. Ponnuswamy and D.J. Victor, Urban Transportation: Planning, Operation, and Management (McGraw Hill Education (India) Private Limited: New York, 2012)
P.K. Sarkar, V. Maitri, and Joshi, G.J., Transportation Panning: Principles, Practices and Policies, 3rd Edition, PHI Learning, Delhi.
P.D. Prevedouros, and C.S. Papacostas, Transportation Engineering and Planning, Pearson Education, 2015.
L.R. Kadiyali, Traffic Engineering and Transport Planning, 9th Edition, Khanna Publishers, Delhi.
Chakraborty and A. Das, Principles of Transportation Engineering, 2nd Edition, PHI Learning, Delhi
NPTEL: "Urban Transportation Systems Planning"

WO201N MECHANICS OF SOLIDS (2-1-0) 3

Introduction to Rigid Bodies and Free-Body Diagrams, and Supports; Simple Truss, Method of Joints; Analysis of Truss - Method of Section; Second Area Moment; Simple stress and Strain, Mechanical Properties of Materials; Statically Determinate Problems; Elastic Constants; Shear Force Diagram and Bending Moment Diagram; Bending Stress Distribution; Shear Stress due to Bending; Beam Deflection – Macaulay's Method; Concept of Compound Stress; Mohr's Circle; Buckling of Columns.

F.P. Beer and E.R. Johnston, Mechanics for Engineers – Statics & Dynamics, Tata McGraw – Hill.
F.L. Singer. Engineering Mechanics – Statics and Dynamics, Harper and Row Pub-lishers.
J.L. Marium and L.G. Kraige, Engineering Mechanics – Vol I & II, John Wiley & Sons.

WO202N MECHANICS OF FLUIDS (2-0-0) 2

Properties and classification of fluids, Hydrostatic forces on surfaces; Pressure and its measurement: Pascal's Law

Pressure variation in a Fluid at rest, Absolute, Gauge, Atmospheric and Vacuum Pressures; Measurement of Pressure-Simple manometers; Differential manometers, Mechanical gauges; Kinematics of fluid flow: Classification of flows, Methods of describing fluid motion; Continuity equation; Velocity and acceleration, Velocity potential and stream function; Dynamics of fluid flow: Euler's equation of motion, Bernoulli's equation

Practical applications of Bernoulli's equation, the Momentum equation; Basics of pipe flow. Hagen-Poiseuille equation; Darcy-Weisbach equation; Uniform flow in open channels: Classification of flow in channels; Discharge through an open channel by Chezy's formula and Manning's Formula.

Modi, P.N. and Seth, S.M., Hydraulics and Fluid Mechanics, 23rd Edition, Standard Book House, Delhi, 2019.

Ven Te Chow, Open Channel Hydraulics, McGraw-Hill, New York, 1959.
Streeter. V.L. and Wylie. E.B., Fluid Mechanics, 9th Edition, McGraw-Hill Book Com-pany, New York, 2010.

WO203N STRENGTH OF MATERIALS LAB (0-0-2) 1

Introduction to Strength of Materials Lab; Tension and compression tests on Mild Steel, Cast Iron; Direct Shear Tests; Bending Test on Mild Steel and Wood; Impact tests [Izod & Charpy]; Torsion Test; Demo on Hardness test [Brinell & Rockwell]; Demo on Fatigue test; Demo on Springs.

Material Testing by Davis.
Mechanical Metallurgy by Diater

WO204N MECHANICS OF FLUIDS LAB (0-0-2) 1

Introduction to Lab and Layout plan; Experiments on flow measurements: V-notch; Rectangular Notch; Venturimeter/ Orifice meter; Water meter; Friction factor for pipe flow; Impact of the jet on the vanes; Hydraulic machinery: Pumps- Centrifugal pump; Turbines- Pelton Turbine; Parshall Flume; Hydraulic ram/ Viscosity / Reynold's number – Demo; Francis and Kaplan Turbine – Demo; Syphons- Volute syphon – Demo.

Modi, P.N. and Seth, S.M., Hydraulics and Fluid Mechanics, 23rd Edition, Standard Book House, Delhi, 2019.
Streeter. V.L. and Wylie. E.B., Fluid Mechanics, 9th Edition, McGraw-Hill Book Company, New York, 2010.

WO211N WATER RESOURCES ENGINEERING (2-0-0) 2

Introduction to Water Resources-Hydrology-Cycle-Water budget-Catchment; Precipitation-Types, Measurement and Presentation of Rainfall Data; Precipitation-Intensity, Duration, Temporal and spatial analysis; Infiltration, Measurement of Infiltration, Infiltration Indices; Evaporation and Transpiration, Measurement and Equations; Introduction to Aquifers, Wells and Groundwater; Run-off; Hydrograph, Components, Baseflow Separation, Effective Rainfall; Unit Hydrograph and its applications; Flood Estimation, Methods and Empirical Formulae; Irrigation-objectives and Methods; Irrigation-Efficiency, Design Principles and Water Requirements; Applications of Water Resources to Drainage; Waterpower Engineering.

Subramanya K, Engineering Hydrology, Tata McGraw Hill, 3rd Edition, 2008.
Garg S. K, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2008.
Ven Te Chow, LW Mays and DR Maidment., Applied Hydrology, McGraw Hill, 1988

WO371N OPEN CHANNEL FLOW AND SEDIMENT TRANSPORT (3-0-0) 3

Steady GVF, SVF, RVF. Unsteady flow: basic equations, velocity of flood wave discharge, flood routing. Bulk properties of sediments, various related theories such as competent velocity concepts, lift concept, critical tractive force concept, Shield's analysis, regimes of flow, bed forms, resistance to flow, bed and suspended load transport, design of canals, reservoir sedimentation, aggradation and degradation of rivers, local scour, sediment samplers

Subramanya. K, Open channel flow, 3rd Edition, Tata McGraw Hill, 2010.
Graf W.H ,Hydraulics of sediment transport, McGraw Hill, 1984.
Garde and Rangaraju, Sediment transport, 2nd Edition, Wiley Eastern, 1985

WO372N CIVIL ENGINEERING SYSTEMS OPTIMIZATION (2-1-0) 3

Introduction to systems approach, simple and complex system, unique features of complex system. Unconstrained optimization, concave & convex functions, constrained optimization - KT conditions, Lagrangian multiplier method. Introduction to LP, Simplex method, Two phase method, Duality in LP, Introduction to DP, Network model, Allocation model, Case studies.

Rao. S.S., Engineering Optimization, 5th Edition, Wiley-IEEE, 2019.

Taha, H..A, Operation Research, 10th Edition, Prentice Hall, 2016.
Panik M..J., Classical optimization foundation, North Holland Pub. Co., 1976.

WO400N GEOGRAPHIC INFORMATION SYSTEMS (2-0-2) 3

Components of GIS, functions, Coordinate Systems, Raster and vector-based GIS and data structures, Spatial data sources Geo-relational Vector data model, Object based vector data model, raster data model, data input, geometric Transformation, Spatial data editing, Attribute data input and management, vector data analysis, Raster data analysis., Applications of GIS in Civil Engineering domains.

Kang-tsung Chang, Introduction to Geographic Information Systems, 8th Edition, Tata McGraw Hill, 2019.
Burrough & McDonnell, Principles of Geographical Information Systems, 3rd Edition, Oxford University Press, 2016.
Yang, Snyder & Tobler, Map projection Transformation principles and applications, Taylor and Francis, 1999.

WO401N SATELLITE DIGITAL IMAGE ANALYSIS (2-1-0) 3

Introduction to Remote sensing and Digital image Processing, Remote sensing data collection Alternatives, Hardware and software issues, Image Quality assessment, Electromagnetic Energy Radiation Principles and radiometric correction, Geometric correction, Image Enhancement, Pattern Recognition, Information extraction from MSS and Hyperspectral data, Change detection studies.

Jensen J.R, Remote Sensing of the Environment: An Earth Resource Perspective 2nd Edition , Dorling Kindersley India Pvt Ltd, 2006.
Jensen J.R., Introductory Digital Image Processing: A remote sensing Perspective,4th Edition, Prentice-Hall,2015.
Lillesand T.M., R.W. Kiefer, and J.W. Chipman. Remote Sensing and Image Interpretation. 7th Edition. John Wiley and Sons. 2015.

WO402N INTRODUCTION TO GEOSPATIAL TECHNOLOGIES AND APPLICATIONS (2-0-2) 3

Introduction to Electromagnetic Spectrum, basics of remote sensing, Interaction with the atmosphere and earth surface features, image acquisitions, image interpretations, spectral properties of earth surface features, land use land cover mapping, satellite and sensors. Spectroradiometer. Introduction to Global Navigation Satellite System. GNSS positioning, GPS. Introduction to GIS, Geospatial data, Coordinate Systems, Vector and Raster Data Model, Data display and cartography, terrain mapping and analysis. Watershed and Viewshed analysis. Applications in Civil Engineering

Chang K., Introduction to Geographic Information Systems, 8th Edition, McGraw-Hill, New York, 2019.
Hofman-Wellenhof. B., Wein,Global Positioning System: Theory and Practice, Springer, 2001
Lillesand, T. and Kiefer, R.W., Remote Sensing and Image Interpretation, 7th Edition ., 2015.

WO421N DESIGN OF HYDRAULIC STRUCTURES (2-1-0) 3

Introduction to Lacey's regime theory, Khosla's theory, Bligh's creep theory, Hydraulic design and drawing of following structures: i. Earthen dam; ii. Gravity dam (OS); iii. Gravity dam (NOS); iv. Surplus weir; v. Canal drop; vi. Canal regulator; vii. Tank sluice with tower head; viii. Direct sluice; ix. Aquaduct.

Punmia,BC and Lal, PBB, Irrigation& Water Power Engineering, 17th Edition, Laxmi Publications, 2021.
Michel, WH. Manual of Irrigation Engineering, Hubbard Press, 1997.
C.S. Murthy, Water Resources Engineering: Principles and Practices, 2nd Edition, New Age International, 2002.

WO422N FUNDAMENTALS OF COASTAL ENGINEERING (2-1-0) 3

Dimensional Analysis and model laws, Basic Wave Hydrodynamics, Linear Wave Theory, Wave Phenomena, Generation of Wind Waves, Wave Spectrum, Wave Forecasting, Basics of Wave Structure Interaction, Tide and tidal variations, Coastal Processes - Littoral Drift, Coastal Erosion and Protection, Design Principles of Breakwaters.

Shore Protection Manual, U.S.Army Corps of Engineers, Coastal Engineering Research Center, 1984.
US Army Corps of Engineers, 'Shore protection manual(SPM)", Vol. 1 &2, Coastal Engg Res. Centre, US Govt. Printing Office , Washington D.C. USA, 1984.
US Army Corps of Engineers, 'Coastal Engg. Manual (CEM)", Parts 1 to 6, Coastal Engg Res. Centre, Washington D.C. USA, 2006.

WO423N BASICS OF OFFSHORE ENGINEERING (2-1-0) 3

Ocean Waves, Currents, Winds, Ice and Mud loading, Basics of Offshore Structures - Jacket, Tower, Gravity platforms – fixed and floating structures, Hybrid Structures and factors governing their selection, Linear wave theory, Morison equation. Linear dynamic analysis, Pile foundations, Bearings capacity of footings.

US Army Corps of Engineers, 'Shore protection manual(SPM)", Vol. 1& 2, Coastal Engg Res. Centre, US Govt Printing Office , Washington D.C. USA., 1984.
US Army Corps of Engineers, 'Coastal Engg. Manual (CEM)", Parts 1 to 6, Coastal Engg Res. Centre, Washington D.C.,USA, 2006.
Weigel R.L.,Recommended practice for Planning, Designing, & Construction of Fixed Offshore Structures - Oceonographical Engg., Prentice Hall, 1969.

WO424N COASTAL EROSION AND ITS MITIGATION (2-1-0) 3

Origin of Coasts, Sediment Transport and Budgeting, Coastal Erosion and Mitigation: A Global Scenario and Indian Perspective, Coastal Processes, Planning and Design of Coastal Protection Works, Innovative Technologies, Performance of Coastal Protection Works in India, Coastal Zone Regulation, Integrated Coastal Zone Management, Coastal Environmental Impact Assessment.

Bruun, P., Port Engineering, Vol. I
Shore Protection Manual, U.S.Army Corps of Engineers, Coastal Engineering Research Center, U.S.Govt. Printing office, Washington D.C., Vol. 1 & 2. 1984.
Ippen A.T., Estuary and Coast line Hydrodynamics McGraw Hill, 1966

WO445N FUNDAMENTALS OF FINITE ELEMENT METHOD (2-1-0) 3

Direct approach. Basic structural elements. Finite difference method, Galerkin weighted residual approach, Rayleigh Ritz method, Element properties. Linear and quadratic elements, shape functions. Isoparametric elements. Numerical integration using Gauss-Legender quadratures, 1-D and 2D problems, Applications in Water and Ocean Engineering.

Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.
Reddy J.N., An Introduction to Finite Element Method, 4th Edition, McGraw Hill, 2020.
Rao. S.S., Finite Element Methods in Engineering, 6th Edition Butterworth and Heinemann, 2017.

WO473N URBAN STORM WATER MANAGEMENT (2-1-0) 3

Excess rainfall, Direct runoff, Peak flow estimation, Concept of IDF curves, Frequency and Return Period, Risk, Design storm, Design Storm Hydrograph. Flow routing. Drainage of urban areas, System components

and Design principles, Storm water management, Airport drainage, Best management practices in Urban and Rural Areas

CPHEEO- Central Public Health & Environmental Engineering Organisation Manual on Storm Water Drainage Systems, Volume I and II, 2019
Ven Te Chow, LW Mays and DR Maidment., Applied Hydrology, McGraw Hill, 1988.
American Society of Civil Engineers Task Committee on Hydrology Handbook, Hydrology Handbook 2 nd edition, ASCE Manuals & Reports on Engg. Practice No.28, 1996 Mays. L.W. Water Resources Handbook,2nd Edition, McGraw Hill, 2019.

WO474N COMPUTATIONAL METHODS IN HYDROLOGY (2-1-0) 3

Introduction, Hydrometeorological measurements, Hydrological models, catchment simulation. Continuity, momentum and energy equations with respect to catchment hydrology, differential equations in hydrology. Numerical Methods, Model applications, Dynamic flow routing, wave motion, unsaturated /saturated ground water flow.

Maidment, D. Hand Book of Hydrology, McGraw Hill, 1st edition, 1993.
Huyakorn and Pinder, Computational methods in subsurface flow, Academic Press, New York, 1983.
Zienkiewicz O.C. and Morgan, K., Finite elements and approximation, 2nd Edition, John Wiley, 2013.

WO475N GEOPHYSICAL EXPLORATION AND IDENTIFICATIONS (2-1-0) 3

Fundamentals of ground water flow, Well Hydraulics and Design, Well characteristics, Production tests and maintenance. Pollution of aquifers: salt water intrusion, Aquifer remediation and management, Groundwater recharge Techniques, RS-GIS applications in Ground water hydrology.

Todd D.K, Ground water hydrology, 4th Edition, Wiley,2009.
Walton, W.C., Ground water resource evaluation. McGraw Hill, 1970.
Raghunath, H.M., Ground Water, 4th Edition New Age International, 2022.

WO477N OPEN SOURCE VIRTUAL INSTRUMENTATION (2-0-2) 3

Introduction to Open Source Virtual Instrumentation, Basics of Open Source Programming and data acquisition, Basics of Open source Sensors, actuators and its characteristics, Design and development of Smart Management Systems using Virtual Instrumentation. Lab component : Open source technique for identification of natural frequency of simplified real world system. Experimental methods of system parameter identification. Experiment on smart monitoring of Agricultural related sensors, pumps, energy meter, Experiment on development of Smart Management Systems, SCADA systems.

D Patranabis, Sensors and Transducers, 2nd Edition, PHI Learning, 2003.
J.P Holman, Experimental Methods for Engineers, 9th Edition, McGrawHill ,2016.
Matt Richardson, Shawn Wallace, Getting Started with Raspberry Pi.,4th Edition, Make Community, LLC, 2021.

WO478N THEORY OF ISOTROPIC ELASTICITY (2-0-2) 3

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants. Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams. Experimental stress analysis.

Wang, C. T., Applied Elasticity, McGraw Hill Co., New York, 1993.
Sokolnikoff, I. S., Mathematical Theory of Elasticity, 3rd Edition, McGraw Hill, New York, 1983.
Volterra & J.H. Caines, Advanced Strength of Materials, Prentice Hall, New Jersey, 1991

WO480N CIVIL ENGINEERING APPLICATIONS OF REMOTELY OPERATED SYSTEMS (2-0-2) 3

Applications of ROS in reconnaissance for entire spectrum of civil works - site inspection, terrain mapping, town planning; zoning, pipeline network, drainage works, road constructions etc. Autonomous monitoring of construction progress using Ground Robots. Use of Aerial Vehicles (Drones) for topographic surveying, structural inspection, and disaster assessment. Underwater Vehicles (ROVs): Deployed for inspection and maintenance of marine and offshore civil structures. Underwater and Hazardous Area Robotics – ROVs and remote tools for disaster zones. Data Processing and Modelling – Creating 3D models and contour maps. Case Studies in Civil Engineering – Applications in urban planning, disaster assessment, agricultural applications and remote monitoring.

Ramesh Singh, Drones in Civil Engineering: Applications and Case Studies.
George A. Bekey, Autonomous Robots: From Biological Inspiration to Implementation and Control, MIT Press, 2005.
John V. Sharp, Underwater Inspection and Repair for Offshore Structure,Wiley, 2021.

WO481N REMOTE SENSING OF CLIMATE CHANGE (2-0-2) 3

Introduction to climate and atmosphere, Radiative properties of gases and greenhouse effect, Global Climate Past, present and future, IPCC, Remote sensing of climate variability, Remote sensing and GIS technological advancements and applications in climate variability analysis, big data and analytical algorithms in climate variability, impact of climate change on natural resources.

Timothy Dube, Munyaradzi Davis Shekede, Cletah Shoko, Terence Mushore., Remote Sensing of Climate, 1st edn., 2024.
Dessler A, Introduction to Modern Climate Change. 2nd Edition. Cambridge University Press. ISBN: 978-521-17315-5, 2016.
Houghton JT, Global Warming: The complete briefing. 5th Edition. Cambridge University Press. Pp.456. ISBN:978-0-521-70916, 2015.

WO482N GIS APPLICATIONS IN CIVIL ENGINEERING (2-1-0) 3

Introduction to GIS, Terrain Analysis, Building web maps, Mobile GIS, Data Integration, Visualization, and Management, Environmental Impact analysis, Infrastructure Management, Site Analysis, Critical Infrastructure Protection, Transportation and Traffic management, Disaster Management, Water Resources Management, CAD Integration, Integrating BIM and GIS for Digital Twin Applications.

Chang K., Introduction to Geographic Information Systems, 8th Edition, McGraw- Hill, New York, 2006.
Richard, Reed and Chris Pettit., Real Estate and GIS: The Application of mapping technologies, Routledge, 1st edn., 2018.

WO483N WEBGIS AND MAPPING FOR WATER RESOURCES AND CIVIL ENGINEERING APPLICATIONS (2-0-2) 3

Introduction to GIS, Data acquisition, Maps and projections, Fundamentals of satellite data acquisition and integration with GIS. The history of web mapping, Understanding FOSS, uses, System architecture. Google Earth Engine, javaScript and API. Python for Geospatial Data. Web GIS and Spatial Decision Support Systems, WMS, Vector tiles, Web mapping API. Geoserver, Geo-processing as a web service, Basics of webpages, HTML, & CSS. *Applications of GEE in Water Resources and Civil Engineering – case studies.*

Chang, Kang-Tsung. Introduction to geographic information systems. 4th ed. Boston: McGraw-Hill, 2017.

Lillesand, T.M., R.W. Kiefer, and J.W. Chipman. Remote Sensing and Image Interpretation. 5th Edition. John Wiley and Sons. 2014.
Fu, Pinde. Getting to Know Web GIS, Third Edition. Redlands: Esri Press, 2018

WO484N INTRODUCTION TO UNMANNED AERIAL VEHICLES AND APPLICATIONS (2-1-0) 3

Overview of UAV Systems, classification. Payloads of UAVs, UAV Mission Planning and Control, Aerial Photogrammetry, Geometry of vertical aerial photographs, Ground coordinates, relief displacement, flight planning. UAV data processing using WebODM. Role of UAV's in construction projects (dams-waterways, highways, building etc.) and other Civil Engineering applications.

Fahlstrom, Paul G., Thomas J. Gleason, and Mohammad H. Sadraey. Introduction to UAV systems. John Wiley & Sons, 2022.
Garg, Pulin K. Unmanned aerial vehicles: An introduction. Mercury Learning and Information, 2021.
Tal, Daniel, and Jon Altschuld. Drone technology in architecture, engineering and construction: A strategic guide to unmanned aerial vehicle operation and implementation. John Wiley & Sons, 2021.

Department of Computer Science and Engineering (CS)
Bachelor of Technology in Computer Science and Engineering

Basic Science Core Courses (BSC)

CY100N	Engineering Chemistry	(3-0-2)4
MA103N	Linear Algebra	(3-0-0)3
MA105N	Probability and Statistics	(3-0-0)3
PH150N	Engineering Physics	(3-0-2)4
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

UC100N	Data Science and AI	(2-0-2)3
CS100N	Computer Programming (C)	(0-0-6)3
CS101N	Computer Programming (Python)	(0-0-6)3
UC101N	Introduction to Engineering	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Program Core Courses (PCC)

CS200N	Theory of Computation	(3-1-0)4
CS201N	Design of Digital Systems	(3-0-0)3
CS202N	Data Structures and Algorithms	(3-1-0)4
CS203N	Discrete Mathematical Structures	(3-1-0)4
CS204N	Data Structures and Algorithms Lab	(0-0-2)1
CS205N	Design of Digital Systems Lab	(0-0-2)1
CS250N	Software Engineering	(1-0-2)2
CS251N	Database Systems	(2-1-0)3
CS252N	Operating Systems	(2-1-0)3
CS253N	Design and Analysis of Algorithms	(3-1-0)4
CS254N	Computer Organization and Architecture	(3-1-0)4
CS255N	Database Systems Lab	(0-0-2)1
CS256N	Operating Systems Lab	(0-0-2)1
CS300N	Machine Learning	(3-0-0)3
CS301N	Computer Networks	(3-1-0)4
CS302N	Compiler Design	(2-1-0)3
CS303N	Distributed Computing	(3-0-0)3
CS304N	Machine Learning Lab	(0-0-2)1
CS305N	Computer Networks Lab	(0-0-2)1
CS306N	Compiler Design Lab	(0-0-2)1

Dept./Institute Elective Courses (DEC)

CS350N	Cryptography and Applications	(3-0-0)3
CS351N	Graph Theory	(3-0-0)3
CS352N	System Programming	(3-0-0)3
CS353N	Big Data Analytics	(3-0-0)3
CS354N	Network Management	(3-0-0)3
CS355N	Microprocessor Systems	(3-0-0)3
CS356N	Artificial Intelligence	(3-0-0)3
CS357N	Full Stack Development	(3-0-0)3
CS358N	Graph Drawing	(3-0-0)3
CS359N	Computing in Autonomous Vehicles	(3-0-0)3
CS360N	Enterprise Resource Planning	(3-0-0)3
CS361N	Soft Computing	(3-0-0)3
CS362N	Computer Graphics	(3-0-0)3
CS363N	Object Oriented Programming	(3-0-0)3
CS364N	Computing with FPGAs	(2-0-2)3
CS365N	Advanced Data Structures	(3-0-0)3
CS366N	Digital Image Processing	(3-0-0)3
CS367N	Advanced Computer Networks	(3-0-0)3
CS368N	Modern Formal Methods and Applications	(3-0-0)3
CS369N	Quantum Computing	(3-0-0)3
CS370N	Distributed Algorithms	(3-0-0)3
CS371N	Cloud Computing	(3-0-0)3
CS372N	Service-Oriented Computing	(3-0-0)3
CS373N	Internet of Things	(3-0-0)3
CS374N	Cyber-Physical Systems	(3-0-0)3
CS375N	Security Engineering	(3-0-0)3
CS376N	Approximation Algorithms	(3-0-0)3
CS377N	Parameterized Algorithms	(3-0-0)3
CS378N	Computational Complexity	(3-0-0)3
CS379N	Randomized Algorithms	(3-0-0)3
CS380N	Vision-Language Models	(3-0-0)3
CS381N	Combinatorial Optimization	(3-0-0)3
CS382N	Algorithmic Learning Theory	(3-0-0)3
CS400N	Internet Protocols and Standardization	(3-0-0)3
CS401N	Simulation and Modelling	(3-0-0)3
CS402N	Software Testing	(3-0-0)3
CS403N	Web Engineering	(3-0-0)3
CS404N	Data Warehousing and Mining	(3-0-0)3
CS405N	Parallel Programming	(3-0-0)3
CS406N	Topics in Information Security	(3-0-0)3
CS407N	Algorithmic Graph Theory	(3-0-0)3
CS408N	Computational Geometry	(3-0-0)3
CS409N	Deep Learning	(3-0-0)3
CS410N	Computer Vision	(3-0-0)3
CS411N	Speech Processing	(3-0-0)3
CS412N	Natural Language Processing	(3-0-0)3
CS413N	Reinforcement Learning	(3-0-0)3
CS414N	Cloud Security	(3-0-0)3
CS415N	Cloud Networking	(3-0-0)3
CS416N	Storage Systems	(3-0-0)3
CS417N	Next Generation Multi-Cloud Architecture	(3-0-0)3
CS418N	Quantum Computer Architecture	(3-0-0)3
CS419N	Wireless Networks	(3-0-0)3
CS420N	Mobile Computing	(3-0-0)3
CS421N	Open Source Networking Technologies	(3-0-0)3
CS450N	High Performance Computing	(3-0-0)3

CS451N	Network Security	(3-0-0)3
CS452N	Heterogeneous Parallel Computing	(3-0-0)3
CS453N	Distributed Database Systems	(3-0-0)3
CS454N	Social Network Analysis	(3-0-0)3
CS455N	Information Storage Management	(3-0-0)3
CS456N	Blockchain Technology	(3-0-0)3
CS457N	Software-Based Networks	(3-0-0)3
CS458N	Database Security	(3-0-0)3
CS459N	Information Centric Networking	(3-0-0)3
CS460N	Quantitative Computer Architecture	(3-0-0)3
CS461N	Computational Discrete Geometry	(3-0-0)3

Internship/Major Project Courses (IPC)

CS398N	Internship I	(0-0-18) 9
CS399N	Major Project I	(0-0-18) 9
CS448N	Internship II	(0-0-18) 9
CS449N	Major Project II	(0-0-18) 9
CS498N	Internship III	(0-0-18) 9
CS499N	Major Project III	(0-0-18) 9

Honors Courses

Students seeking an Honors degree shall credit a minimum of 15 additional credits from Postgraduate courses offered by the respective Department, as decided by the DUGC.

Suggested Plan of Study for B.Tech. in Computer Science and Engineering:

Semester	I	II	III	IV	V	VI	VII	VIII
1	CY100N	PH150N	CS200N	CS250N	CS300N	Elective	Elective	Elective
2	MA103N	MA105N	CS201N	CS251N	CS301N	Elective	Elective	Elective
3	CS100N	CS101N	CS202N	CS252N	CS302N	Elective	CS448N / CS449N	CS498N / CS499N
4	DE100N	UC101N	CS203N	CS253N	CS303N	CS398N / CS399N	-	-
5	UC103N	UC102N	CS204N	CS254N	CS304N	-	-	-
6	PL1XWN / PL1X9N	PL1YWN / PL1Y9N	CS205N	CS255N	CS305N	-	-	-
7	-	-	PL2XWN / PL2X9N	CS256N	CS306N	-	-	-
8	-	-	-	PL2YWN / PL2Y9N	PL3XWN / PL3X9N	-	-	-

Requirements for B.Tech. in Computer Science and Engineering:

Category of Courses	Minimum Credits to be Earned
Foundation Courses Basic Science Core (BSC): 20 General Engineering Courses (GEC): 12	32
Programme Core Courses (PCC)	51
Electives Courses (EC) Dept./Institute Elective Courses (DEC), MOOC Courses (0 – 9 credits)	21
Internship/Major Project Courses (IPC)	27
Life Skill Courses (LSC)	20
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

CS200N THEORY OF COMPUTATION (3-1-0) 4

Introduction to Theory of Computation; set membership problem; alphabets, strings and formal languages; basic language concepts and operations on languages. Introduction to finite automata; deterministic finite automata (DFA); formal definition of DFA; transition diagrams and tables; language accepted by DFA. Designing DFAs; examples of DFA constructions; regular languages and their properties. Regular languages; closure properties of regular languages; union, concatenation and Kleene star operations. Pumping Lemma for Regular Languages; statement and intuition; examples of non-regular languages. Nondeterministic finite automata (NFA); computation trees; formal definition of NFA; equivalence of DFA and NFA. ε-NFA; automata with epsilon transitions; conversion of ε-NFA to DFA. Regular expressions; languages denoted by regular expressions; conversion between regular expressions and automata. Closure properties and algebraic properties of regular languages; reversal property; DFA minimization and equivalent states. Introduction to context-free languages; Context-Free Grammar; derivations; leftmost and rightmost derivations; parse trees. Simplification of CFG; elimination of useless symbols, ε-productions and unit productions; Chomsky Normal Form; pumping lemma for CFL. Pushdown Automaton; PDA definition; configurations; acceptance by empty stack and final state; relation between PDA and CFL. Introduction to Turing Machine; formal definition; components of a Turing machine; configurations; designing simple Turing machines; language acceptance. Variants of Turing Machine; multitape and nondeterministic Turing machines; recursively enumerable and recursive languages; decidability and the Halting Problem.

J. E. Hopcroft and J. D. Ullman, Introduction to Automata, Languages and Computation, Addison-Wesley, 1969.
Michael Sipser, Introduction to the Theory of Computation, Cengage Learning, 2013.
H. E. Lewis and C. H. Papadimitriou, Elements of the Theory of Computation, Prentice-Hall of India, 1981.
Derick Wood, Theory of Computation, John Wiley & Sons, 1987.
NPTEL – Theory of Computation
https://nptel.ac.in/courses/106104028
NPTEL - Theory of Computation
https://nptel.ac.in/courses/106104148
MIT Open Courseware – Theory of Computation
https://ocw.mit.edu/courses/18-404j-theory-of-computation-fall-2020/

CS201N DESIGN OF DIGITAL SYSTEMS (3-0-0) 3

Number systems, binary arithmetic, and signed numbers. Binary codes, and conversions with digital system examples. Boolean algebra and switching functions. Logic gates, canonical forms, and simplification techniques. Combinational circuits: adders, subtractors. Multiplexers, decoders, and algorithmic design methods. Sequential circuits: latches, flip-flops, registers, counters, timing analysis, and state diagrams. Registers and Counters. Timing analysis and state diagram. Algorithmic synthesis of sequential circuits using state tables and state minimization techniques. Logic optimization: two-level minimization, Karnaugh maps, Quine–McCluskey method. Multi-level logic optimization, Boolean factoring, decomposition, and technology mapping concepts. Computer-aided synthesis, logic optimization tools, and introduction to digital CAD frameworks. Hardware Modelling using VHDL: dataflow, behavioral, structural Modelling, and simulation basics.

Alan B. Marcovitz,"Introduction to Logic Design", Mc Graw-Hill, 3rd Edition, 2009.
Giovanni De Micheli, "Synthesis and Optimization of Digital circuits", McGraw-Hill, 2003
Zvi Kohavi, "Switching and finite automata theory", McGraw-Hill. 1978.
Morris Mano, "Digital Design with an Introduction to Verilog", Pearson Education India,5th Edition, 2013.
NPTEL: https://onlinecourses.nptel.ac.in/noc21_ee39/preview

CS202N DATA STRUCTURES AND ALGORITHMS (3-1-0) 4

Introduction to Data Structures & Algorithms: Definition and classification of data structures, Abstract Data Types (ADT), Role of algorithms in problem solving. Algorithm Analysis & Design Techniques: Time and space complexity, Asymptotic notations (Big-O, Ω, Θ), best, average, and worst-case analysis, Dynamic Memory Allocation: Static vs dynamic memory allocation. Linked Lists: Singly linked list, doubly linked list, Circular linked list, Operations and applications of linked lists. Searching Algorithms: Linear search, Binary search, Performance comparison, Applications of searching algorithms. Sorting Algorithms: Bubble sort, Selection sort, Insertion sort, Merge sort, Quick sort etc, Comparison of sorting techniques. Stacks and Queues: Stack operations and applications, Queue operations and types (simple, circular, priority queue, deque), Array and linked list implementations. Recursion & Expression Evaluation: Concept of recursion, Recursive vs iterative solutions, Infix, postfix, and prefix expressions, Evaluation of arithmetic expressions using stacks. Trees: Tree terminology and properties, Binary trees, Tree traversals (inorder, preorder, postorder), Binary Search Trees (BST) and operations. AVL Trees concepts and rotations, Priority queues, Binary heaps (min-heap and max-heap), Applications of heaps. Graphs: Graph terminology and types, Graph representations, Graph traversals: BFS and DFS, Applications of graph traversal.

Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman, Data Structures and Algorithms, Addison-Wesley, 2003.
Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures and Algorithms in C++, Universities Press, 2007.
Clifford A. Shaffer, A Practical Introduction to Data Structures and Algorithms, Prentice Hall International, 1997.
Mark Allen Weiss, Data Structures and Algorithm Analysis with C++, Addison-Wesley, 1996.
Jon Kleinberg and Éva Tardos, Algorithm Design, Addison-Wesley, 2005.
Jean-Paul Tremblay and Paul G. Sorenson, An Introduction to Data Structures with Applications, Tata McGraw-Hill, 2001.
Cormen, Leiserson, Rivest, and Stein, "Introduction to Algorithms", MIT Press, Third Edition, 2009.
Jeff Erickson, Algorithms, 1st Edition, 2019.
NPTEL: https://nptel.ac.in/courses/106102064
Coursera: https://www.coursera.org/learn/msft-data-structures-and-algorithms

CS203N DISCRETE MATHEMATICAL STRUCTURES (3-1-0) 4

Overview of discrete structures, basic counting principles, rule of sum, rule of product, permutations and combinations. Propositions, logical connectives, truth tables, logical equivalence, tautologies and contradictions, laws of logic. Methods of proof including direct proof, proof by contradiction, proof by contrapositive, mathematical induction and strong induction. Sets and set operations, countable and uncountable sets. Relations and their properties (reflexive, symmetric, transitive), equivalence relations, equivalence classes and partitions of sets. Functions and types of functions (injective, surjective, bijective), composition and inverse of functions. Pigeonhole principle, Graph theory including graphs and basic terminology, types of graphs, bipartite graphs and basic graph operations. Connectivity in graphs, Euler paths and circuits, Hamiltonian paths and circuits, basic graph coloring. Number theory including divisibility, prime numbers, fundamental theorem of arithmetic, greatest common divisor, Euclidean algorithm, modular arithmetic and Chinese remainder theorem.

R.P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition, Pearson, 2008.
Kenneth Rossen, Discrete Mathematics and its Application, 7th Edition, McGraw-Hill, 2011.
B. Kolman, R.C. Busby, S.C. Ross, Discrete Mathematical Structures, Pearson Education India; 6 edition, 2015.
Lovasz, Combinatorial Problems and Exercises, 2nd Edition, North Holland,1993
Introduction to Discrete Mathematics, NPTEL https://onlinecourses.nptel.ac.in/noc22_cs33/preview
Discrete Mathematics - NPTEL

https://nptel.ac.in/courses/106108227

CS204N DATA STRUCTURES AND ALGORITHMS LAB (0-0-2) 1

Array Operations: Creation of arrays, Insertion, deletion, searching, and traversal, Use of malloc / calloc / free or new / delete. Searching: Linear and binary search. Sorting Algorithms: Implementation of bubble, insertion, selection, merge, Quick sort, Radix sort, bucket sort and counting sort. Linked List Operations: Singly linked list implementation, Doubly and circular linked lists, List manipulation. Stack Implementation: Stack using arrays, Stack using linked lists, Infix to postfix/prefix conversion, Evaluation of postfix/prefix expressions using stacks. Queue Implementation: Simple queue using arrays, Circular queue, Queue using linked lists, Recursive programs. Tree Creation and Traversal: Binary tree creation, Tree traversals- inorder, preorder, postorder. Binary Search Tree: BST insertion, deletion, and search, Performance analysis. Balanced Trees: AVL tree implementation, Tree rotations and balancing. Heap Implementation: Min-heap and max-heap, Priority queue operations using heaps. Graph Algorithms: Graph representations, Depth-First Search (DFS), Breadth-First Search (BFS), Shortest path algorithms, Minimum Spanning Tree algorithms.

Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman, Data Structures and Algorithms, Addison-Wesley, 2003.
Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures and Algorithms in C++, Universities Press, 2007.
Mark Allen Weiss, Algorithms, Data Structures, and Problem Solving with C++, Addison-Wesley, 1996.
Cormen, Leiserson, Rivest, and Stein,"Introduction to Algorithms", MIT Press, Third Edition, 2009.
Jeff Erickson, Algorithms, 1st Edition, 2019.
NPTEL: https://nptel.ac.in/courses/106102064
Coursera: https://www.coursera.org/learn/msft-data-structures-and-algorithms

CS205N DESIGN OF DIGITAL SYSTEMS LAB (0-0-2) 1

Design of basic logic gates using Boolean expressions and truth tables. Half and full adders, subtractors, binary arithmetic circuits, and applications. Encoders and decoders: design, implementation, and practical examples. Multiplexers and demultiplexers: design, selection logic, and applications. Code conversion circuits and arithmetic logic design examples. Flip-flops: SR, JK, D, T types, timing parameters, and applications. Counters: up, down, up-down counters, synchronous and asynchronous design. Shift registers and shifters: logical, arithmetic, and bidirectional operations. Structural Modelling of adders, subtractors, encoders, and decoders. Structural Modelling of multipliers and complex combinational circuits. Finite State Machine design: Moore machine concepts and examples. Implementing real-life problems through HDL simulator.

Alan B.Marcovitz, "Introduction to Logic Design", McGraw-Hill, 3rd Edition, 2009.
Giovanni De Micheli, "Synthesis and Optimization of Digital circuits", McGraw-Hill., 2003
Zvi Kohavi, "Switching and finite automata theory", McGraw-Hill. 1978.
Morris Mano, "Digital Design with an Introduction to Verilog", Pearson Education India, 5th Edition,2013
NPTEL: https://onlinecourses.nptel.ac.in/noc21_ee39/preview

CS250N SOFTWARE ENGINEERING (1-0-2) 2

Introduction to software engineering, software development life cycle, Waterfall, iterative, incremental, spiral and agile models, requirements engineering, feasibility study, requirement elicitation, analysis and validation, software requirements specification, IEEE standards, documentation techniques, software metrics, process, project and product metrics, measurement principles, software design fundamentals, architectural design, modularity, cohesion, coupling, object-oriented software engineering, UML diagrams, design principles and patterns, software testing fundamentals, unit, integration, system and acceptance testing, verification and validation, reliability, performance verification and quality assurance, software cost estimation models, COCOMO, software complexity analysis models, software project management, scheduling, risk

management, CASE tools, introduction to software security, basics of threats, vulnerabilities and security policies.

Roger S. Pressman, Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill;
Ian Sommerville, Software Engineering, 9th Edition, Addison-Wesley, 2010; Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India, 2009;
Pankaj Jalote, An Integrated Approach to Software Engineering, 3rd Edition, Springer;
Shari Lawrence Pfleeger and Joanne M. Atlee, Software Engineering: Theory and Practice, 4th Edition, Pearson;
Carlo Ghezzi, Mehdi Jazayeri and Dino Mandrioli, Fundamentals of Software Engineering, 2nd Edition, Prentice Hall;
Stephen R. Schach, Object-Oriented Software Engineering, McGraw-Hill.

CS251N DATABASE SYSTEMS (2-1-0) 3

Database Systems, database concepts and architecture, data models, database schema and instances, entity-relationship model, relational model, relational algebra, relational calculus, SQL, advanced SQL, database design, functional dependencies, normalization, decomposition, integrity constraints, transaction management, concurrency control, database recovery, indexing and hashing, file organization, query processing and optimization, database security and authorization, database administration, and introduction to modern database systems. .

Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson;
C. J. Date, An Introduction to Database Systems, 8th Edition, Pearson;
Abraham Silberschatz, Henry F. Korth and S. Sudarshan, Database System Concepts, 7th Edition, McGraw-Hill; Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw-Hill; Thomas Connolly and Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition, Pearson;
Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widom, Database Systems: The Complete Book, 2nd Edition, Pearson;

CS252N OPERATING SYSTEMS (2-1-0) 3

Introduction to Operating Systems - OS concepts, functions and types. Process Management - Process states, PCB and process creation. CPU Scheduling - Scheduling criteria and scheduling algorithms. Multithreading - Thread concepts and multithreading models. Synchronization - Critical section, semaphores and monitors. Deadlocks - Prevention, avoidance and recovery. Memory Management - Paging, segmentation and virtual memory. File Systems - File organization and allocation. Disk Scheduling - Disk scheduling algorithms and management.

Silberschatz, Galvin & Gagne, "Operating System Concepts", 9th Edition, John Wiley & Sons, 2013.
Milan Milenković, "Operating Systems: Concepts and Design", McGraw Hill, New York, 2000.
Andrew S. Tanenbaum, Vrije University, Amsterdam, The Netherlands, Herbert Bos, "Modern Operating Systems" 2015.
Sumitabha Das, Unix Concept and applications, Tata McGraw-Hill, 2003
NPTEL-IIT madras: https://nptel.ac.in/courses/106106144
NPTEL-IIT Delhi: https://nptel.ac.in/courses/106102132
NPTEL - IISc Bangalore: https://nptel.ac.in/courses/106108101
Coursera- BITS Pilani: https://www.coursera.org/learn/bits-operating-systems
IIT Bombay lecture: https://www.cse.iitb.ac.in/~mythili/os/

CS253N DESIGN AND ANALYSIS OF ALGORITHMS (3-1-0) 4

Introduction to algorithms, problem solving, models of computation, and role of algorithm analysis. Algorithm analysis basics: time and space complexity, asymptotic notations. Best, average, and worst-case analysis of algorithms with examples. Lower bound theory and fundamental limits of algorithmic problems. Divide and Conquer technique: principles, recurrences, and classic examples. Greedy algorithms: design strategy, correctness, and applications. Dynamic Programming: principles, optimization problems, and applications. Amortized analysis and randomized algorithms with illustrative examples. Computational complexity classes: P, NP, and PSPACE problems and Reducibility concepts; NP-hard and NP-complete problems with examples. Approximation algorithms for NP-hard problems and performance guarantees.

Cormen, Leiserson, Rivest, and Stein, "Introduction to Algorithms", MIT Press, Third Edition, 2009.
Jeff Erickson, Algorithms, 1st Edition, 2019.
Dasgupta, Papadimitrou and Vazirani, "Algorithms", McGraw-Hill Education, 2006.
Horowitz, Sahni, and Rajasekaran, "Computer Algorithms" Silicon Press, 2007.
Kleinberg and Tardos, "Algorithm Design", Pearson, 2005.
Goodrich and Tamassia, "Algorithm Design", Wiley, 2001.
Coursera (Stanford), https://www.coursera.org/specializations/algorithms
MIT Open Courseware, https://ocw.mit.edu/courses/6-006-introduction-to-algorithms/
GeeksforGeeks, https://www.geeksforgeeks.org/analysis-of-algorithms/
Khan Academy, https://www.khanacademy.org/computing/computer-science/algorithms
Brilliant.org, https://brilliant.org/courses/computer-science-algorithms/
P-NP Tutorials, https://www.tutorialspoint.com/design_and_analysis_of_algorithms/
Awesome Algorithms (GitHub), https://github.com/tayllan/awesome-algorithms

CS254N COMPUTER ORGANIZATION AND ARCHITECTURE (3-1-0) 4

Introduction to computers; Functional units; High-level system block diagram. Data representation: number systems; signed and unsigned integers; fixed and floating point representation. Arithmetic operations; examples. Instruction Set Architecture (ISA); RISC principles; CISC vs. RISC. Instruction formats, Addressing modes. Example RISC ISA: instruction encoding; assembly language programming; simple programs. Compilation process; compiler phases; assembly code; object code; linking and loading. Arithmetic Logic Unit (ALU) design; arithmetic and logical operations; performance considerations. Processor data path design; single-cycle and multi-cycle data path; control signals. Control unit design; hardwired control; microprogrammed control; overview. Memory hierarchy; cache memory; main memory; virtual memory concepts. Input/Output subsystem; I/O techniques; interrupts; DMA; storage devices.

David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 4e (ARM), 5e (MIPS), 6e (RISC-V), Elsevier.
M. Morris Mano, Computer System Architecture, 3rd Edition, Pearson, 2007.
Hamacher, Vranesic, Zaky, Computer Organization, 5th Edition, Tata McGraw-Hill, 2011.
John P. Hayes, Computer Architecture and Organization, 3rd Edition, McGraw-Hill, 1998.
David M. Harris and Sarah L. Harris, Digital Design and Computer Architecture, 2nd Edition, Elsevier, 2013.
NPTEL – Computer Organization and Architecture
https://nptel.ac.in
Berkeley CS61C – Great Ideas in Computer Architecture
https://cs61c.org/
Ripes – RISC-V Visual Simulator
https://github.com/mortbopet/Ripes

CS255N DATABASE SYSTEMS LAB (0-0-2) 1

DBMS lab environment and tools, open-source DBMS installation and configuration, ER Modelling and ER-to-relational mapping, database and table creation, data types and integrity constraints, SQL DML operations,

aggregate functions, GROUP BY and HAVING clauses, joins, nested queries and subqueries, EXISTS and IN operators, views, indexes, stored procedures, functions, triggers and database backup, MongoDB query operations, frontend integration, database design and schema implementation, and development of a database application using MySQL with a suitable frontend environment.

Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson Education, 2016.
Raghu Ramakrishnan, Database Management Systems, 3rd Edition, Tata McGraw Hill, 2014.
Vikram Vaswani, MySQL™: The Complete Reference, 1st Edition, McGraw Hill Education, 2017.
James Groff, Paul Weinberg and Andy Oppel, SQL: The Complete Reference, 3rd Edition, 2017.
NPTEL Courses.
SQL Course for Beginners: Learn SQL Using MySQL Database.
MySQL for Beginners.
Introduction to Structured Query Language (SQL).
HackerRank, SQL Practice Challenges.
Oracle Academy, Database Design and Programming with SQL.

CS256N OPERATING SYSTEMS LAB (0-0-2) 1

Basic Shell and Process Management - Shell commands, system calls and process creation. Multithreading and Synchronization - POSIX threads, mutexes and semaphores. CPU Scheduling - FCFS, SJF, Priority and Round Robin. Concurrent Programming and Deadlocks - Critical section, synchronization problems and deadlock avoidance. Memory Management - Memory allocation and page replacement algorithms. Inter-Process Communication - Pipes, message queues and shared memory. File Systems - File operations, permissions and allocation methods. Disk Scheduling - FCFS, SSTF, SCAN and C-SCAN.

Silberschatz, Galvin & Gagne, “Operating System Concepts”, 9th Edition, John Wiley & Sons, 2013
Milan Milenković, “Operating Systems: Concepts and Design”, McGraw-Hill, New York, 2000.
Andrew S. Tanenbaum, Vrije University, Amsterdam, The Netherlands, Herbert Bos, “Modern Operating Systems” 2015.
Sumitabha Das, Unix Concept and applications, Tata McGraw-Hill, 2003
YouTube lecture: https://www.youtube.com/playlist?list=PLlr7wO747mNp5nn0hteJFnt1rpdx6GG-_
IIT Bombay lecture: https://www.cse.iitb.ac.in/~mythili/os/
YouTube lecture:
https://www.youtube.com/watch?v=afmzgInow58&list=PLWjmN065fOfGdAZrlP6316HVHh8jlvefD

CS300N MACHINE LEARNING (3-0-0) 3

Introduction and applications of machine learning, Different Learning Paradigms, Machine learning challenges. Evaluation metrices, importance of cross validation, Overfitting and underfitting, Bias Variance trade-off. Linear Regression, Multivariate Regression, Gradient descent, Polynomial regression, Lasso regression. Classification Problems, Logistic Regression, Multiclass classification with Logistic Regression, Linear Discriminant Analysis. Instance based learning, k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN. Probability Overview, Naive Bayes Classifier, Gaussian Naive Bayes Classifier. Neural network: MP model, Perceptron, multilayer network, backpropagation, different activation and loss functions, Gradient descent optimization algorithms, Regularization for Neural Networks. Introduction to convolutional neural networks, convolution operation, pooling operation, popular architectures like LeNet, AlexNet, VGG, ResNet, Transfer Learning Clustering: Partitional Clustering and Hierarchical Clustering. Cluster Types, Attributes and Salient Features. k-Means, Hierarchical and Density-based Clustering Algorithms. Ensemble methods: voting, bagging, boosting.

Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.

Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
Hastie, T., R. Tibshirani, and J. H. Friedman. The Elements of Statistical Learning: Data Mining, Inference and Prediction. New York, NY: Springer, 2001. ISBN: 9780387952840.
MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003. ISBN: 9780521642989.
Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
Machine Learning by Andrew Ng, Coursera, https://www.coursera.org/learn/machine-learning
Google Machine Learning Crash Course, https://developers.google.com/machine-learning/crash-course
Machine Learning with Python – IBM, Coursera, https://www.coursera.org/learn/machine-learning-with-python
Advanced ML Algorithms & Unsupervised Learning, Coursera, https://www.coursera.org/learn/packt-advanced-ml-algorithms-unsupervised-learning-konpg
Trees, SVM and Unsupervised Learning, Coursera, https://www.classcentral.com/course/trees-svm-and-unsupervised-learning-191496
Clustering & Classification with Machine Learning in Python, Udemy,
https://www.classcentral.com/course/udemy-clustering-classification-with-machine-lear-130927
NPTEL Machine Learning Courses, https://onlinecourses.nptel.ac.in/

CS301N COMPUTER NETWORKS (3-1-0) 4

OSI and TCP/IP models, network architectures, layering principles, and protocol data units (PDUs). Physical layer, transmission media, Nyquist/Shannon capacity, line coding, and digital modulation techniques. Digital multiplexing, circuit switching, packet switching, and networking switching fabrics. Data Link Layer: Framing, error detection, and MAC sublayer. Error correction: Hamming codes, Cyclic codes, and Convolutional encoding/decoding techniques. Flow control, Ethernet, Wireless LAN, and VLANs. Network Layer: IPv4 addressing, classful vs classless (CIDR), subnetting, and IP datagram format. IPv6 transition, ICMP, DHCP, and Network Address Translation (NAT) operations and limitations. Routing algorithms: Distance Vector (RIP), Link State (OSPF), and hierarchical routing concepts. Transport Layer: UDP, TCP segment structure, connection management, flow control, and congestion control algorithms. Application layer protocols including HTTP, FTP, SMTP, DNS and client-server communication. Network security basics, firewall concepts, secure communication and socket programming.

Kurose, James F. Computer networking: A top-down approach featuring the Internet, 6/E. Pearson Education India, 2005/2012.
Kevin R Fall and W. Richard Stevens, TCP/IP illustrated, volume 1: The protocols. Addison-Wesley, 2011.
Ilya Grigorik, High Performance Browser Networking: What every web developer should know about networking and web performance. “O’Reilly Media, Inc.",2013.
Peterson, L. L., & Davie, B.S. Computer Networks: A Systems Approach. Elsevier, 2007.
Tanenbaum, A. S., & Wetherall, D. (1996). Computer networks (pp.I-XVII). Prentice hall, 1996.
Google — The Bits and Bytes of Computer Networking
https://www.coursera.org/learn/computer-networking
Covers OSI, TCP/IP, IP addressing, routing, DNS/DHCP basics. Coursera
Cisco Networking Academy — Networking Basics
https://www.netacad.com/courses/networking-basics
Introductory networking course from Cisco. netacad.com
Swayam — Computer Networks (fundamentals)
https://onlinecourses.swayam2.ac.in/cec19_cs07/preview
Covers OSI, protocols, layers, and network models. onlinecourses.swayam2.ac.in
Great Learning Academy — Basics of Computer Networking
https://www.mygreatlearning.com/academy/learn-for-free/courses/basics-of-computer-networking
Simplilearn — Free Computer Networking Course

https://www.simplilearn.com/free-computer-networking-course-skillup
Covers OSI, TCP/IP, IP addressing, subnetting and routing. Simplilearn.com
edX — Computer Networking Courses
https://www.edx.org/learn/computer-networking

CS302N COMPILER DESIGN (2-1-0) 3

Introduction to language processing systems, compiler structure, phases of compilation, and the role of compilers. Overview of lexical analysis, tokens, patterns, lexemes, input buffering, and symbol table concepts. Regular languages, regular expressions, finite automata, DFA, and NFA construction and minimization. Design and implementation of lexical analyzers using automata-based techniques. Introduction to syntactic analysis, context-free grammars, derivations, and parse trees. Top-down and bottom-up parsing techniques, LL and LR parsers, and parser construction. Semantic analysis, type checking, scope resolution, and syntax-directed definitions. Error detection, error recovery strategies, and syntax-directed translation schemes. Intermediate representations, three-address code, syntax trees, and intermediate code generation. Procedure abstraction, runtime environments, activation records, and storage allocation strategies. Code generation techniques, instruction selection, register allocation, and issues related to the target machine.

Aho, Lam, Sethi, Ullman Compilers: Principles, Techniques, and Tools, Addison-Wesley, (2007/2013) ISBN-10:0321486811
Y.N. Srikant and Priti Shankar: The Compiler Design Handbook: Optimizations and Machine Code Generation, CRC Press, 2002. ISBN084931240X
Tremblay and Sorenson: The Theory and Practice of Compiler Writing, McGraw-Hill, 1985.
Grune, Bal, Jacobs, Langendoen: Modern Compiler Design, John Wiley and Sons, (2000)
Steven Muchnick: Advanced Compiler Design and Implementation, Morgan Kaufmann, 1997. ISBN1-558-60320-4.
Keith Cooper, Linda Torczon: Engineering a Compiler, Morgan Kaufmann; 2 edition (2011)
Andrew Appel: Modern Compiler Implementation in Java, Cambridge University Press, (2002).
NPTEL YouTube Channel, IISc Bengaluru.
https://youtube.com/playlist?list=PLbMVogVj5nJQNjkHZgwuAlfQ9tzmQDxjA&si=IPkeIYKh3fQFWotZ
NPTEL Swayam, IIT Kharagpur. https://nptel.ac.in/courses/106105190
YouTube Channel, IIT Madras https://youtu.be/dyAwtsrg2us?si=UNXIxhETy0TCLe_8

CS303N DISTRIBUTED COMPUTING (3-0-0) 3

Distributed systems and applications, Message passing mechanisms IPC and RPC. Processes: Threads, Clients, Servers, Code Migration, Agents. Naming: Naming entities, Mobile entities, Distributed operating systems, Distributed file systems and services. Synchronization: logical clocks, Global state, Distributed transactions, Consistency and replication: models, protocols, examples. Fault tolerance: Process resilience, Reliable communication, Recovery. Security management. Distributed file and Web-based systems, Social computing.

Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, John Wiley & Sons,
Inc ISBN number: 9780132392273, 2004.
Pradeep Sinha, Distributed Operating Systems Concepts and Design, PHI, 2000.
George Couloris, Jean Dollimore & Time Kindberg, Distributed Systems: Concepts & design, 2nd ed Addision Wesley 2003.
Gerard Tel. Introduction to Distributed Algorithms, Cambridge University press, 2000.

CS304N MACHINE LEARNING LAB (0-0-2) 1

Python for Machine Learning: Installation of Python (Anaconda/COLAB), libraries (NumPy, Pandas, Matplotlib), and basic data frame operations. Handling missing data, Feature scaling (Normalization,

Standardization), Train-test split, Data visualization. Model Evaluation and Cross Validation: Implement evaluation metrics: Accuracy, Precision, Recall, F1 score, Confusion matrix, k-fold cross validation, Demonstration of overfitting and underfitting. Implementing simple and multiple linear regression to predict continuous data. Implementation of various Regularization Methods: Ridge Regression, Lasso Regression, Effect of regularization parameters. Logistic Regression: Implementing binary classification to predict discrete outcomes. k-Nearest Neighbour (kNN): Implement kNN classifier, Effect of different values of k, Distance metrics, Distance-weighted kNN, Visualization using Voronoi regions. Naive Bayes Classifier: Gaussian Naive Bayes classifier, Text classification using Naive Bayes, Compare Naive Bayes with Logistic Regression. Decision Trees: Implementing the ID3 algorithm or CART for classification tasks. Neural Networks: Implement Perceptron, Multilayer neural networks, Different Activation functions, Training using backpropagation. Convolutional Neural Networks: Implement a CNN for image classification, Demonstrate convolution and pooling, Train a simple CNN (e.g., LeNet-like model). Clustering Algorithms: k-Means clustering, Hierarchical clustering, DBSCAN clustering, Cluster visualization. Ensemble methods: Voting classifier, Bagging (Random Forest), Boosting (AdaBoost)

Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
Hastie, T., R. Tibshirani, and J. H. Friedman. The Elements of Statistical Learning: Data Mining, Inference and Prediction. New York, NY: Springer, 2001. ISBN: 9780387952840.
MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003. ISBN: 9780521642989.
Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
Machine Learning by Andrew Ng, Coursera, https://www.coursera.org/learn/machine-learning
Google Machine Learning Crash Course, https://developers.google.com/machine-learning/crash-course
Machine Learning with Python – IBM, Coursera, https://www.coursera.org/learn/machine-learning-with-python
Advanced ML Algorithms & Unsupervised Learning, Coursera, https://www.coursera.org/learn/packt-advanced-ml-algorithms-unsupervised-learning-konpg
Trees, SVM and Unsupervised Learning, Coursera, https://www.classcentral.com/course/trees-svm-and-unsupervised-learning-191496
Clustering & Classification with Machine Learning in Python, Udemy, https://www.classcentral.com/course/udemy-clustering-classification-with-machine-lear-130927
Tutorials Point Master Machine Learning Course, https://www.tutorialspoint.com/course/master-simplified-supervised-machine-learning-trade/index.asp

CS305N COMPUTER NETWORKS LAB (0-0-2) 1

Introduction to networking tools, Linux networking commands, basic topology design. Design and analysis of bus, star, ring, and mesh network topologies. Intro to Wireshark & Frame Inspection. Bit Stuffing, Error Detection Implementation. Hamming & Convolutional Coding Implementation. VLAN Configuration and Trunking (802.1Q)

Subnetting (VLSM) & IPv4 Addressing. DHCP & NAT Implementation. Static Routing and Dynamic Routing. UDP Client-Server Performance. TCP Congestion Window Analysis. Analyzing HTTP, DNS, and SMTP Traffic. Custom Topologies via Scripting. Firewalls, Access Control Lists (ACLs)

James F. Kurose, Computer networking: A top-down approach featuring the Internet, 6/E. Pearson Education India, 2005/2012.
Ilya Grigori, High Performance Browser Networking: What every web developer should know about networking and web performance. "O'Reilly Media, Inc.", 2013.
Online Resources: Interactive animations, Video notes from Kurose and Ross 2012.

Wire shark assignments, Presentation slides, interactive exercises from the following link: http://wps.pearsoned.com/ecs_kurose_compnetw_6/216/55463/14198700.cw/
Cisco Networking Academy – Networking Basics
https://www.netacad.com/courses/networking-basics
Fundamentals of networks, protocols, and topology.
Coursera – The Bits and Bytes of Computer Networking (Google) https://www.coursera.org/learn/computer-networking
Wireshark Official Tutorials & Docs https://www.wireshark.org/docs/
Packet capture & analysis lab walkthroughs.
ZeroMQ – Official Guide & Examples https://zeromq.org/get-started/
Hands-on socket programming with ZeroMQ patterns.
GeeksforGeeks – Socket Programming (C/Python) https://www.geeksforgeeks.org/socket-programming/
NPTEL – Computer Networks (Prof. R. Anitha, IIT Madras) https://nptel.ac.in/courses/106/105/106105214/
Mininet – Walkthrough & Documentation http://mininet.org/walkthrough/

CS306N COMPILER DESIGN LAB (0-0-2) 1

Introduction to compiler phases; installation and configuration of LEX/FLEX, YACC/Bison, and C /Python development environment. Design and implement a lexical analyzer for C tokens using LEX-based grammar. Extend the lexical analyzer to construct and manage symbol tables with token attributes. Implement a desk calculator using operator precedence parsing techniques in YACC. Develop a YACC parser for arithmetic expressions, handling operator precedence and associativity. Extend the parser to support C control structures, such as if, while, do-while, and for statements. Generate parse trees and implement basic syntax error detection and recovery mechanisms. Implement semantic analysis, including type checking, scope handling, and declaration processing, as an integrated component with the parser. Generate three-address intermediate code for arithmetic and boolean expressions using syntax-directed translation. Generate intermediate code for control flow constructs using backpatching techniques. Apply basic code optimization techniques such as constant folding and dead code elimination.

Andrew Appel: Modern Compiler Implementation in Java, Cambridge University Press, (2002).
John R. Levine, Tony Mason, Doug Brown: Lex & Yacc, 2nd/updated edition, O'Reilly & Associates, (October 1992).
Robert Morgan: Building an Optimizing Compiler, Digital Press, 1998. ISBN1-55558-179-X
NPTEL Swayam, IIT Kharagpur. https://nptel.ac.in/courses/106105190

CS350N CRYPTOGRAPHY AND APPLICATIONS (3-0-0) 3

Cyber security and cybercrimes, Types of attacks, Case study, Elementary number theory, Primality, abstract algebra., Symmetric cryptography, Asymmetric cryptography, Key management, Integrity and authentication, Cryptographic application in data networks, Applications in software systems, Security aware software development life cycle, Ethical hacking and secure coding.

Neal Koblitz, A Course in Number Theory and Cryptography, Springer, 1987.
Ivan Niven, Herbert S. Zuckerman. Hugh L. Montgomery, An Introduction to The Theory of Numbers, John Wiley, 2008.
Alfred Menezes, Paul van Oorschot, Scott Vanstone, Hand book of Applied Cryptography, CRC, 1997. William Stalling, Cryptography and Network Security-Principle and Practice, Prentice Hall, 2016.

CS351N GRAPH THEORY (3-0-0) 3

Graphs, Preliminaries on Graphs, Matchings in Bipartite graphs- Konig's theorem, Hall's theorem. Matchings in general graphs- Tutte's theorem, 2-connected graphs, Ear-decomposition, Menger's theorem, Dirac's extensions for Menger 's theorem. Edge connectivity, Vertex coloring- Greedy coloring, Degeneracy of graphs, Coloring of planar graphs, Brook's theorem, Edge coloring- Konig's theorem, Vizing's theorem, Perfect graphs.

R. Diestel, Graph Theory, Second edition, Springer, 2000.
D. West, Introduction to Graph Theory, Second Edition, PHI, 2003.
J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, North Holland, 1976.
A. Schrijver, A course in Combinatorial Optimization, Cambridge university press, 2000.

CS352N SYSTEM PROGRAMMING (3-0-0) 3

System APIs, GNU libc. UNIX systems, File I/O, filters and file manipulation. Command line arguments and environment variables. Terminal handling and text based screen applications. Interrupt handling. Finding the time. Mixing C and scripts. Resource management algorithms. Distributed systems concepts, Concurrent programming.

Anthony Richard John, Systems Programming: Designing and Developing Distributed Applications, Morgan Kaufamnn, 2015.
Adam Hoover, System Programming with C and Unix, Pearson,2009 Robert Love, Linux Kernel Development. Addison-Wesley Professional, 2010 Robert Love, Linux System Programming, O'Reilly Media; 2 edition.2013

CS353N BIG DATA ANALYTICS (3-0-0) 3

Big Data fundamentals, sources and types of big data, data storage and distributed computing, Hadoop ecosystem and HDFS, MapReduce programming model and Apache Spark for large-scale data processing, data storage and processing, data preprocessing, statistical analysis, data mining, machine learning, and real-world applications, healthcare, finance, business, social media analytics, Tools, Hadoop, Spark, Hive, Python, and SQL, along with topics on Big Data security, privacy, and ethics.

Anand Rajaraman, Jeffrey D. Ullman and Jure Leskovec, Mining of Massive Datasets, 3rd Edition, Cambridge University Press, 2021.
Jules S. Damji, Brooke Wenig, Tathagata Das and Denny Lee, Learning Spark: Lightning-Fast Data Analytics, 2nd Edition, O'Reilly Media, 2020.
Bill Chambers and Matei Zaharia, Spark: The Definitive Guide: Big Data Processing Made Simple, O'Reilly Media, 2018.
Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011.
EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015.

CS354N NETWORK MANAGEMENT (3-0-0) 3

Network management overview, Network management, SNMP and network management, TMN, network management applications, Management of heterogeneous networks with intelligent agents, Network security management, Internet management (IEEE Communications, May, Oct. 03), QoS in IP networks, Basic methods & theory for survivable network design & operation, Network planning, Network management standards, Case study of network management tools used at NITK Central Computing Centre, Use cases of software-defined networking (SDN) for managing networks.

Subramanian, M. Network management: Principles and Practice. Pearson Education India, 2010.
Burke, J. R., Richard, B., & Burke, R. Network management: concepts and practice, a hands-on approach. London: Pearson Education, 2004.

CS355N MICROPROCESSOR SYSTEMS (3-0-0) 3

Microprocessor architecture, 8086, Instruction set, Subroutines, Programming examples, Software development with interrupts; Intel 80286, 80386; Programmable peripheral devices, 8255, 8253,8259, 8257, Motorola 68000 processors, 68020, 68030; Mother boards, I/O bus, I/O channel, BIOS, DOS, PC bus, Multibus

I & II, VME, CRT controller, Floppy disc controller, Hard disc controller, CDROM drive, Serial communication controller, Pen drive, Mouse drive.

Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, 6/e, Penram International Publishing, 2013.
Douglas V. Hall, Microprocessors & Interfacing Barry B. Brey, "The Intel Microprocessors: Architecture, Programming & Interfacing" PHI, 6th Edition, 2003.
Lice & Gibson, "Microcomputer System 8086 / 8088" PHI, 2nd Edition

CS356N ARTIFICIAL INTELLIGENCE (3-0-0) 3

AI introduction, history and applications, Production systems. State Space Search, Proposition and first order logic, inference and deduction, resolution refutation, answer extraction, knowledge based systems, logic programming and constrained logic programming, non-monotonic reasoning, State-space, plan space and partial order planning, planning algorithms, Probabilistic reasoning, belief networks, Inductive learning, decision trees, logical approaches, computational learning theory, neural networks, reinforcement learning, Intelligent agents, natural language understanding, Applications.

1. Stuart J Russell, Peter Norvig, Artificial intelligence: A Modern Approach, Prentice Hall, Fourth edition, 2020.
2. Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan-Kaufmann, 1998.
3. Judea Pearl, Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley Publishing Company, 1984.
4. David L. Poole, Alan K Mackworth, Artificial Intelligence: Foundations of Computational Agents, 3rd edition, Cambridge University Press, 2023.

CS357N FULL STACK DEVELOPMENT (3-0-0) 3

Full Stack Development- Frameworks, Libraries, Technologies. Version control- Concepts, tools, actions, git, GitHub. Python and JavaScript for full stack. Databases for full stack –MySQL, MongoDB, Mongoose, REST API. Front-end Development –HTML, React, Virtual DOM, Angular CSS. Back-end Runtime Environment and Frameworks-Node.js, Express, Django. APIs-concepts, development, architecture, testing.

Chris Northwood, The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer, A Press.
Philip Ackermann, Full Stack Web Development The Comprehensive Guide. SAP Press.
Riaz Ahmed, Full stack Web Development for Beginners: Learn Ecommerce Web Development using HTML5, CSS3, Bootstrap, JavaScript, MySQL, and PHP. Independent Publisher.
FrankZammetti, Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker (First Edition). A press.

CS358N GRAPH DRAWING (3-0-0) 3

Prerequisite course: Data Structures and Algorithms

Planarity testing, canonical ordering, force-directed embedding, Schnyder woods, Tutte embedding, Spring embedding with repulsion, Graph-distance preserving embedding, Rectangle and Square Representation: Rectangle and Square Representations of Planar Graphs, Square tilings with prescribed combinatorics, Blocking and anti-blocking pairs of polyhedral, map labelling, edge bundling, contact representation and visibility representation. Orthogonal Graph Drawing.

Di Battista, G., Eades, P., Tamassia, R., Tollis, I., Graph Drawing: Algorithms for the Visualization of Graphs, Prentice Hall, Upper Saddle River, 1999.
Trudeau, R., Dots and Lines, Kent State University Press, 1976.
Preparata, F., Shamos, M., Computational Geometry: An Introduction, Springer-Verlag, New York, 1985.

Thulasirama, K., Swamy, M., Graphs: Theory and Algorithms, John Wiley and Sons, New York, 1992. ity Press, 2009.
Handbook of Graph Drawing and Visualization, Roberto Tamassia, Editor, CRC Press, 2013.
Planar Graph Drawing, Takao Nishizeki, Md. Saidur Rahman, World Scientific Publishing Company, 2004.

CS359N COMPUTING IN AUTONOMOUS VEHICLES (3-0-0) 3

Autonomous driving technologies, algorithms. Localization - GNSS, LiDAR, HD Maps, Visual and Wheel Odometry. Perception – Detection, Segmentation, Stereo Optical Flow, Scene Flow, Tracking, CNNS for Perception. Prediction & Routing. Planning and control- Traffic Prediction, Motion Planning, Feedback Control, Reinforcement based planning and control. Cloud platforms for autonomous driving.

Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot. Creating Autonomous Vehicle Systems. Morgan & Claypool.
Lance Eliot, Michael Eliot. Autonomous Vehicle Driverless Self-Driving Cars and Artificial Intelligence: Practical Advances in AI and Machine Learning. LBE Press Publishing.
Michael E. McGrath. Autonomous Vehicles: Opportunities, Strategies and Disruptions. Independent.

CS360N ENTERPRISE RESOURCE PLANNING (3-0-0) 3

Need and importance of ERP in organisations, ERP architecture and components, ERP implementation lifecycle, business processes and reengineering, ERP functional modules and integration, ERP implementation strategies and methodologies, ERP project planning and management, ERP technologies, Database management in ERP, web-enabled ERP and mobile ER, cloud ERP and SaaS, business intelligence and analytics in ERP, enterprise application integration (EAI), ERP security and data privacy and case studies.

Alexis Leon, Enterprise Resource Planning, 4th Edition, McGraw Hill Education, 2019.
Ellen Monk and Bret Wagner, Concepts in Enterprise Resource Planning, 4th Edition, Cengage Learning, 2013.
Mary Sumner, Enterprise Resource Planning, Pearson Education, 2005.
Jagan Nathan Vaman, ERP in Practice: A Case Study Approach, Tata McGraw-Hill, 2007.
D. P. Goyal, Enterprise Resource Planning: A Managerial Perspective, McGraw Hill Education, 2014.
Klaus, H. Laudon and Jane P. Laudon, Management Information Systems: Managing the Digital Firm, Pearson Education.

CS361N SOFT COMPUTING (3-0-0) 3

Introduction to soft computing, Fuzzy logic, Applications of fuzzy logic, Genetic algorithms, Artificial neural networks; Supervised, unsupervised and reinforcement learning; Basic neural network models, Adaline, Linear and nonlinear activation functions, Loss functions, Gradient descent method, Back propagation algorithm, Multi-layer neural networks.

J.-S. R. Jang, C.-T. Sun, and E. Mizutani, Neuro-Fuzzy and soft Computing, PHI Learning, 2009.
G. J Klir and B Yuan. "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall. Martin T Hagan et.al., “Neural network design” (2nd edition), 2014
Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press, 2000.
Taqiq Rashid, “Make your own Neural Network”, 2016
David E. Goldberg, Genetic Algorithms In Search, Optimization and Machine Learning, Pearson Education, 2002

CS362N COMPUTER GRAPHICS (3-0-0) 3

Introduction to computer graphics: Basic raster graphics algorithms for drawing 2D primitives, 2D transformations, Window-to-viewport transformation, Input devices and interactive techniques. 3D graphic: Viewingin 3D, Projections, Basics of solid Modelling, 3D transformations.Multimedia building blocks: Aud -

basic sound concepts, Music, Speech, MIDI versus digital audio, Audio file formats, Sound for the web, Images and graphics- basic concepts, Computer image processing. Video and animation –basic concepts, Animation techniques, Animation for the web.

Foley J. D., Van Dam A., Feiner S. K. & Hughes J. F., Computer Graphics Principles and Practice, Second Edition, Addison Wesley
Hearn D. & Baker P.M, Computer Graphics, Prentice Hall India Koegel Buford J. F., Multimedia System, Addison Wesley

CS363N OBJECT ORIENTED PROGRAMMING (3-0-0) 3

Programming paradigms, Software design principles, Arrays and Strings, Objects and classes, Operator overloading, Inheritance and Polymorphism, Exception handling, Templates, Multithreaded Programming, Case studies.

B Jarne Stroustrup, "The C++ Programming Language", Addison Wesley, 2004. Stanley B Lippman, "The C++ Primer", Addison Wesley, 2005.
Grady Booch, James Rumbaugh, Ivar Jacobson, "Unified Modelling Language User Guide", Addison-Wesley Professional, 1998.
Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", Prentice Hall Edition, 2004.

CS364N COMPUTING WITH FPGAS (2-0-2) 3

Behavioral Modelling and simulation. Hardware description languages: Combinational and sequential design, state machine design, synthesis issues, test benches. Overview of FPGA architectures and technologies: Logic block architecture, I/O block architecture, Programmable interconnects. Unified Computer Infrastructure API Case Studies: OneAPI. Applications – Computer Architecture prototypes on FPGAs, ML accelerators on FPGAs. Simulation / Implementation exercises on Xilinx / Intel-Altera boards.

Frank Bruno, FPGA Programming for Beginners, Packt Publishing Ltd., 2021
Monk, Programming FPGAs: Getting Started with Verilog, McGraw-Hill Education, 2016
Robert Dunne, Computer Architecture Tutorial Using an FPGA: ARM & Verilog Introductions, Gaul Communications, 2020.
Ashenden, Digital Design using Verilog, Elsevier, 2007
Clive Maxfield, The Design Warriors's Guide to FPGAs, Elsevier, 2004

CS365N ADVANCED DATA STRUCTURES (3-0-0) 3

Data structures and its operations, 2-3 trees, Red-black trees, binary heaps, binomial and Fibonacci heaps, Skip lists, universal hashing. Data structures for maintaining ranges, intervals and disjoint sets with applications, Advanced graph algorithms and applications, Internet Algorithms, Compression algorithms, Search engine algorithms, Spiders and crawlers, Integer and polynomial arithmetic, Modular arithmetic, String matching Algorithms, NP-Completeness and approximation algorithms.

Thomas Cormen, Charles E Leiserson and Ronald D River, Introduction to Algorithms, PHI, 2001.
Mark Allen Weiss, Algorithms, Data Structures and Problem Solving with C++, Addison Wesley, 2002. Fundamentals of data structures in C++, by E. Horowitz, S. Sahni, and D. Mehta, Second Edition, Silicon Press, 2007

CS366N DIGITAL IMAGE PROCESSING (3-0-0) 3

Introduction to image processing, Sampling and quantization, basic gray level transformations, point operations, histogram processing, convolution and correlation, image smoothing and sharpening, Fourier transform, Noise models, Noise reduction in spatial domain and frequency domain, state-of-the-art filters for

denoising images corrupted with various kinds of noise, Detection of discontinuities (point, line and edge detection), classical edge detection methods, thresholding, morphological image processing, Hough transform, color image processing.

Rafael C. González, Richard E. Woods, "Digital Image Processing", 3rd Ed., PHI, 2007.
Anil K. Jain, "Fundamentals of Digital image Processing", Prentice Hall, US Ed., 1989.
Rafael C. González, Richard Eugene Woods, Steven L. Eddins, "Digital Image Processing using MATLAB", Pearson Education India, 2004.
Willam K Pratt, Digital Image Processing, Wiley-Interscience Publication, Third Edition, 2001.
AL Bovik (Editor), "Handbook of Image and Video Processing", Academic Press

CS367N ADVANCED COMPUTER NETWORKS (3-0-0) 3

Different types of optimizations proposed for improving the performance of TCP/IP: TCP Fast Open, window scaling, Slow start restart, Proportional rate reduction, Increasing initial congestion window. Problems of UDP and peer to peer applications with NAT, Linux queue disciplines such as Random early detection, Proportional integral controller, Controlled delay and explicit congestion notification (ECN). Differences between the internet architecture and data center network architecture, Performance problems in data center networks and existing solutions, the need for software defined networks in Data center networks, and the importance of network function virtualization.

Kurose, James F. Computer networking: A top-down approach featuring the internet, 6/E. Pearson Education India, 2005/2012
Grigorik, Ilya. High Performance Browser Networking: What every web developer should know about networking and web performance. "O'Reilly Media, Inc.", 2013.
Khan, S. U., & Zomaya, A. Y. (Eds.). (2015). Handbook on data centers. Springer, 2015. Peterson, L. L., & Davie, B. S. Computer networks: A Systems Approach. Elsevier, 2007.

CS368N MODERN FORMAL METHODS AND APPLICATIONS (3-0-0) 3

Basics of Discrete mathematics- Set Theory and Functions, Basic Set Definitions, Propositional Logic, and Predicate

Logic. Fundamentals of Formal Methods- Formal methods in computing specification; Formal description techniques in communication, software, and hardware systems. Behavioral Specifications- Unity, Transition Systems. Verification Tools- Verification by model checking, LTL, CTL, SAT. Deduction Systems- Proof methods and techniques, Applications to Automated Theorem Proving, Abstract Data Types and Algebraic Specification. Type Systems and Constructive Logics- Binary decision diagrams, Algorithms for reduced OBDDs, Symbolic model checking. Case Studies of Selected Applications.

Formal Methods in Computer Science, Jiacun Wang and William Tepfenhart, Chapman and Hall/CRC, 1st Edn.,2019.
Formal Methods, Flemming Nielson and Hanne Riis Nielson, Springer, 2019.
Theory and Practice of Formal Methods, Erika Ábrahám, Marcello Bonsangue, and Einar Broch Johnsen, Springer,1st Edn., 2016.
Formal Methods: Industrial Use from Model to the Code, Jean-Louis Boulanger, Wiley-ISTE, 2012.
Principles of Model Checking, Christel Baier and Joost-Pieter Katoen, The MIT Press, 2008.
Logic in Computer Science- Modelling and Reasoning About Systems, Michael Huth and Mark Ryan, Cambridge University Press, 2005.

CS369N QUANTUM COMPUTING (3-0-0) 3

Introduction to Quantum Computing: Quantum Bits, Bloch Sphere Representation of a Qubit, Multiple Qubits. Linear Algebra Revisits: Complex Numbers versus Real Numbers, Vectors, Scalar Multiplication, Vector Addition, and Bases. Introduction to Quantum Mechanics: The Postulates of Quantum Mechanics, EPR

Paradox, Quantum Physics Essentials, Atoms, Elementary Particles, and Molecules, Hilbert Spaces, and Uncertainty. Quantum Circuits: Single Qubit Gates and Operations, Multiple Qubit Gates and Operations, Design and Simulation of Quantum Circuits. Quantum Algorithms: Introduction to Quantum Algorithms, Deutsch's Algorithm, Deutsch's-Jozsa Algorithm, Shor's Algorithm, Grover's Algorithm and Generalizations, etc. Quantum Information Processing and Error Correction: Quantum Noise and Quantum Operations, Classical Noise and Markov Processes, Quantum Operations, Distance Measures for Quantum Information; Quantum Error-Correction- Classical Error Correction, Classical Three-Bit Code, Fault Tolerance and Error Recovery.

Quantum Computing, Bernhardt, Chris, MIT Press, 1st edn., 2019.
Quantum Computation and Quantum Information, Michael A. Nielsen, Isaac L. Chuang, Cambridge University Press, 10th Ed., 2010.
Quantum Mechanics: The Theoretical Minimum, Leonard Susskind and Art Friedman, Penguin, Latest Edition, 2015.
Fundamentals of Quantum Computing Theory and Practice, Venkateswaran Kasirajan, Springer, 1st Edn. 2021.
An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, Michele Mosca, Oxford University Press, 1 st Edn., 2007.
Introduction to Quantum Algorithms via Linear Algebra, second edition, Richard J. Lipton and Kenneth W. Regan. MIT Press 2021.
Linear Algebra and Its Applications, David C. Lay, Steven R. Lay, Pearson, 5th Edition, 2015.
Quantum Computing, Parag K. Lala, McGraw-Hill Education, 1st Edition, 2019.

CS370N DISTRIBUTED ALGORITHMS (3-0-0) 3

Prerequisite course: Data structures and Algorithms, Overview of distributed computing; basics of distributed network algorithms; time in distributed systems; distributed mutual exclusion; distributed snapshots and global state collection; graph algorithms; coordination algorithms; faults and fault tolerance; distributed consensus and agreement algorithms; distributed transactions; group communication; replicated data management; self-stabilization; applications in wireless sensor networks.

Wan Fokkink, Distributed Algorithms: An Intuitive Approach, 2nd Edition, MIT Press, 2018.
Nancy A. Lynch, Distributed Algorithms, Morgan Kaufmann, 1996.
Hagit Attiya and Jennifer Welch, Distributed Computing: Fundamentals, Simulations, and Advanced Topics, 2nd Edition, Wiley, 2004.
Maarten van Steen and Andrew S. Tanenbaum, Distributed Systems, 4th Edition, Pearson.
Gerard Tel, Introduction to Distributed Algorithms, Cambridge University Press, 2000.
Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 2007.

CS371N CLOUD COMPUTING (3-0-0) 3

Concept of cloud computing and evolution. Define SLAs and SLOs and illustrate their importance in Cloud Computing, Threats in cloud security, Common cloud providers and their associated cloud stacks and popular cloud use case scenarios. Cloud infrastructure: Cloud Reference Architecture. Cloud software deployment considerations such as scaling strategies, Load balancing, Fault tolerance, and Optimizing for cost. Cloud resource management: Virtualizing CPUs, full virtualization, Para-virtualization, and Memory virtualization. Cloud storage: Organization of data and storage. Various types of data within the data taxonomy and classify different data types within the data taxonomy. HDFS, Google GFS, Big-Table. Programming models: Fundamental aspects of parallel and distributed programming models.

Anthony T Velte, Cloud Computing: A Practical Approach, McGraw Hill, 2010
Kai Hwang, Jack Dongarra, and Geoffrey C. Fox. 2011. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things (1st. ed.). Morgan Kaufmann Publishers Inc., 2011

J. Lin and C. Dyer, Data Intensive Text Processing with MapReduce, Morgan and Claypool, 2010
T. Velte, A. Velte, R. Elsenpeter, Cloud Computing, A Practical Approach, McGraw Hill, 2009
Rajkumar Buyya, James Broberg, Andrzej M., Cloud Computing: Principles and Paradigms, Wiley, 2010.
Jimmy Lin and Chris Dyer, Data-Intensive Text Processing with Mapreduce Morgan and Claypool, 2010.
Dan Marinescu, Cloud Computing: Theory and Practice, Morgan Kaufmann, 2013

CS372N SERVICE ORIENTED COMPUTING (3-0-0) 3

SOA reference model and service models, SOA business case, Service design principles, BPEL, Modelling SOA with CPN and OPNET, SOA, SOAP and REST, SOA infrastructure, SOA governance, Web services, identity and security, Technologies, Tooling and Vendors.

Thomas Erl, Service-Oriented Architecture: Concepts, Technology and Design, 2006.
Mark Hansen. SOA Using Java Web Services

CS373N INTERNET OF THINGS (3-0-0) 3

Internet of Things (IoT) Fundamentals and Enabling Technologies, IoT and M2M, IoT Architecture and Design Methodology, Sensors and Actuators, IoT Communication and Networking Protocols, MQTT, CoAP and HTTP, Building IoT Systems with Arduino, and Raspberry Pi, IoT Data Analytics, Cloud, Edge and Fog Computing for IoT, IoT Security, Case Studies and Real-World IoT Applications.

Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015
Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.
Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

CS374N CYBER-PHYSICAL SYSTEMS (3-0-0) 3

Overview of Security and Privacy in Cyber-Physical Systems- Defining Security and Privacy, Cybersecurity and Privacy, Physical Security and Privacy, and Cyber-Physical Terrorism. Privacy Issues for Cyber Physical Systems-CPS Reference Model, Device Level, Security and Privacy Threats in CPSs, Local Network Security for CPSs, Secure Device Bootstrapping. Security and Privacy for Cloud-Interconnected CPSs- Securely Storing CPS Data in the Cloud, Protection of CPS Data, Securely Processing CPS Data in the Cloud, and Privacy for Cloud-Based CPSs. Theoretic Metrics Quantifying Privacy in Cyber-Physical Systems- Social Perspective and Motivation. Cyber-Physical Systems and National Security Concerns- Future Attacks. Legal Considerations of Cyber-Physical Systems and the Internet of Things.

Security and Privacy in Cyber-Physical Systems- Foundations, Principles, And Applications, Fink, Glenn A., Jeschke, Sabina, Song Houbing, IEEE Press, 1 st Edn., 2018.
Cyber-Physical Systems: Architecture, Security and Application, Song Guo, Deze Zeng, Springer, 1st Ed., 2019.
Secure and Trustworthy Transportation Cyber-Physical Systems, Yunchuan Sun and Houbing Song, Springer, 1st Edn., 2017.

CS375N SECURITY ENGINEERING (3-0-0) 3

Basics of Security, Security Requirements, Significance of Psychology in Security, Social Engineering, Vulnerabilities, Threats and Exploits, Attacks and Countermeasures, Security Analysis and Risk Assessment, Security Models and Policies, Secure Coding and Configuration Security Standards and regulations

Anderson, R., Security engineering: a guide to building dependable distributed systems. John Wiley & Sons.

Bishop, Matt, Introduction to computer security.
Schneier, Bruce, Beyond fear: Thinking sensibly about security in an uncertain world. New York: Copernicus books.

CS376N APPROXIMATION ALGORITHMS (3-0-0) 3

NP optimization; approximation ratios; design techniques for approximation algorithms: greedy algorithms, local search, and other combinatorial techniques; dynamic programming and approximation schemes; randomized techniques; LP-based techniques, including randomized rounding, primal-dual methods, iterative rounding, local ratio, and dual fitting; semidefinite-programming-based techniques. Hardness of approximation: approximation classes, non-approximability results, gap techniques, approximation-preserving reductions, and the PCP theorem.

David P. Williamson and David B. Shmoys., The design of Approximation Algorithms, Cambridge University Press 2011
Vijay V. Vazirani Approximation Algorithms, First Editions, Springer – Verlag Berlin Heidelberg, 2003
G. Ausiello et al., Complexity and Approximation: Combinatorial Optimization Problems and their Approximability Properties, Springer, Second corrected printing 2003.
SarielHar-Peled, Geometric Approximation Algorithms, AMS Series in mathematical Surveys and Monographs 2011

CS377N PARAMETERIZED ALGORITHMS (3-0-0) 3

Introduction: Review of NP-hardness, approaches to proving NP-hardness, motivation for parameterized algorithms, notion of fixed-parameter tractability, and formal definitions of key concepts. Basic toolkit: kernelization, branching and bounded-depth search trees, iterative compression, and greedy localization. Kernelization techniques: crown decomposition, sunflower lemma, expansion lemma, and kernels based on linear programming. Randomized methods: randomization in parameterized algorithms, color-coding technique, chromatic coding technique, basic pseudorandom objects, and derandomization. Treewidth: parameterized algorithms based on dynamic programming over tree decompositions, and computing and approximating treewidth. Lower bounds: notion of fixed-parameter intractability, W-hierarchy, parameterized reductions and examples, and lower bounds for kernelization.

M.Cryan, F.V. Fomin, L. Kowalik, D. Lokshtanov, D. Marx, M. Pilipczuk, M. Pilipczuk, and S. Saurabh, Parametrized Algorithms, Springer, June 2015
R. Niedermeier, Invitation to fixed-parameter algorithms, Oxford University press 2006
R.G. Downey and M.R. Fellows, Fundamentals of Parameterized Complexity, Springer 2013

CS378N COMPUTATIONAL COMPLEXITY (3-0-0) 3

Review of Complexity Classes: L, NL, P, NP, PSPACE and EXP, log-space and polynomial-time reductions, completeness, Hierarchy theorems, Savitch, and Immerman theorems. Circuit complexity, P/Poly, NC and AC, P-completeness, polynomial hierarchy, Karp Lipton theorem, alternation, relationship between circuit depth and space complexity. Randomized Complexity classes: Adleman's theorem, Sipser Gacs theorem, counting class, #P, Valiant’s Theorem, Toda’s theorem (no proof). Arthur Merlin games, Graph Isomorphism problem, Goldwasser-Sipser theorem, Interactive Proofs, Shamir's theorem.

S. Arora and H. Barak, Computational Complexity: A Modern Approach, Cambridge University Press, 2009.
C. H. Papadimitriou, Computational Complexity, 1/e, Addison Wesley, 1993
R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
V. Vazirani, Approximation Algorithms, 1/e, Springer, 2004.

CS379N RANDOMIZED ALGORITHMS (3-0-0) 3

Prerequisite course: Data Structures and Algorithms

Tail Bounds: Review of discrete probability spaces, probabilistic method, Markov and Chebyshev inequalities, moments of a random variable, Chernoff bounds, Martingales, Hoeffding and Azuma inequalities. Randomised Data Structures and Algorithms: Randomised data structures and algorithms: Skip lists, hashing, randomised min-cut, verifying matrix multiplication, randomised quicksort, randomised selection, coupon collector's algorithm, randomized pattern matching. number theoretic algorithms: primality testing - Miller Rabin test. Markov Chain Monte Carlo Markov chains and random walks, stationarity, Markov chain Monte Carlo (MCMC) methods, volume estimation, randomised complexity classes. Derandomization: Probabilistic method and derandomization, the basic counting argument, expectation argument, derandomization using conditional expectation, sample and modify method, second Moment method, constructive Lovasz Local Lemma (LLL), Schwartz–Zippel lemma.

R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995., 2009.
M. Mitzenmacher and E. Upfal, Probability and Computing: Randomization and probabilistic techniques in algorithms and data analysis, 2/e, Cambridge University Press, 2017.
C. H. Papadimitriou, Computational Complexity, Addison Wesley, 1994.
M. Jerum, Counting, Sampling and Integrating: Algorithms and Complexity, 3rd Edition, Birkhauser, 2003.

CS380N VISION-LANGUAGE MODELS (3-0-0) 3

Introduction to Vision-Language Models : Evolution of multimodal AI, Applications, Overview of key benchmarks, Foundations of Vision and Language Representations: Image embeddings, Language embeddings, Multimodal representation learning principles, Image Captioning and Visual Question Answering: Encoder-decoder architectures for captioning, Attention mechanisms in captioning , VQA architectures and datasets, Limitations and challenges, Cross-Modal Pretraining Frameworks: Contrastive learning: CLIP, ALIGN, Joint embedding models vs. fusion models, Zero-shot transfer and open-vocabulary recognition, Pretraining objectives, Advanced VLM Architectures, Emerging paradigms, Multimodal Generation : Text-to-image, Image-to-text, Vision-language-to-video models, Prompt engineering and controllable generation, Evaluation metrics, Limitations of current, Hands-on Applications and Projects.

Tunstall, L., von Werra, L., & Wolf, T. (2022). Natural Language Processing with Transformers, Revised Edition: Building Language Applications with Hugging Face. O'Reilly Media, Inc. ISBN: 978-1-0981-3678-9.
Foster, D. (2023). Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play (2nd ed.). O'Reilly Media, Inc. ISBN: 978-1-098-13417-4.
Noyan, M., Farré, M., Marafioti, A., & Zohar, O. (2026). Vision Language Models: Building VLMs with Hugging Face. O'Reilly Media.
Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.

CS381N COMBINATORIAL OPTIMIZATION (3-0-0) 3

Prerequisite course: Data Structures and Algorithms

Linear programming (LP), simplex algorithm, duality in LP, dual simplex algorithm, applications of duality and primal-dual algorithm to solve graph problems. Polynomial-time algorithms for LP: ellipsoid algorithm, interior point methods; Karmakar's algorithm. Integer linear programming (ILP); total unimodularity and its applications. Algorithms for solving ILP problems.

Christos H. Papadimitriou and Kenneth Steglitz, Combinatorial Optimization: Algorithms and Complexity, Prentice-Hall, 1982.
John Lee, A first course in combinatorial optimization, Cambridge University Press, 2004.
Jiri Matousek, Bernd Gartner, Understanding and Using Linear Programming, Springer, 2007.
William J. Cook, William H. Cunningham, William R. Pulleyblank, Alexander Schrijver, Combinatorial Optimization, Wiley, 1st edition, 1997

CS382N ALGORITHMIC LEARNING THEORY (3-0-0) 3

Prerequisite course: Data structures and Algorithms, Probability and Statistics

Foundations of Learning Theory: How do we formalize machine learning problems? Right framework for right problems (Statistical vs Online). Trade-offs between models. How many samples are needed for given accuracy? Statistical Learning Theory: PAC and Agnostic PAC frameworks, empirical risk minimization, uniform convergence, empirical process theory, bounds on learning rates (MDL, PAC-Bayes). Complexity Measures and Learnability: Rademacher complexity, VC dimension, covering numbers, fat-shattering dimension. Necessary and sufficient conditions for learnability. Online Learning Theory: Sequential minimax analysis, regret bounds, Littlestone dimension, online supervised learnability, exponential weights algorithm, mirror descent, convexity, and rates. Computational Hardness of Learning: NP-hard learning problems, Reduction techniques. Lower bounds through oracle models of optimization. Applications and Extensions: Uses of learning theory in optimization, approximation algorithms, and (if time permits) connections to bandit algorithms and generic learning methods via relaxations.

Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
Mohri, Rostamizadeh, and Talwalkar, Foundations of Machine Learning, 2nd Edition, MIT Press, 2018

CS400N INTERNET PROTOCOLS AND STANDARDIZATION (3-0-0) 3

Internet architecture, Internet design principles, IPv4 limitations, IPv6 addressing, address types, Neighbor Discovery Protocol, Stateless Address Auto configuration, DHCPv6, ICMPv6, extension headers, transition mechanisms, dual-stack, NAT64, DNS64, IPv6 deployment strategies, IPv6 security considerations. DNS architecture, recursive and authoritative name servers, DNS resolution process, root name servers, TLDs, resource records, reverse DNS, DNS caching, Anycast DNS, DNSSEC fundamentals, DNSSEC validation, DNS over HTTPS, DNS over TLS, DNS privacy. Internet routing architecture, Autonomous Systems, BGP fundamentals, path selection, peering and transit, Internet Exchange Points (IXPs), QUIC architecture, HTTP/3 operation, transport security, protocol performance considerations, Introduction to RPKI, Route Origin Authorization, route origin validation. Internet operations ecosystem, Network Operations Centers, Internet registries, APNIC services, NIXI ecosystem, Internet resource management, IPv6 deployment best practices, DNS operations, BGP operational practices, routing security, MANRS principles, operational troubleshooting. Internet measurement fundamentals, active measurements, passive measurements, latency, packet loss, jitter, throughput, Quality of Experience, ping, traceroute, path analysis, network telemetry, measurement methodologies. RIPE Atlas architecture, APNIC measurement platforms, CAIDA datasets, Internet topology analysis, BGP monitoring, routing anomaly detection, RPKI deployment and validation, BGP hijacks, route leaks, Internet outage analysis, operational case studies. History of Internet standardization, IETF organization, IRTF research groups, IAB, IESG, RFC Editor, Internet-Drafts, RFC categories, Internet standards lifecycle. RFC writing guidelines, normative language, interoperability testing, open-source implementations, reference implementations, protocol testing. ICANN, IANA, Regional Internet Registries, APNIC Policy Development Process, NIXI initiatives, Internet Society, W3C, IEEE, ITU-T, 3GPP, emerging Internet protocols, network programmability, secure Internet protocols, future Internet research, standards for next-generation Internet technologies.

Christian Huitema, Routing in the Internet, 2nd Edition, Prentice Hall.
Barry Raveendran Greene and Philip Smith, BGP4: Inter-Domain Routing in the Internet, Addison-Wesley.
Olivier Bonaventure, Computer Networking: Principles, Protocols and Practice, Saylor Foundation
Selected RFCs: RFC 1958, RFC 2026, RFC 8200, RFC 4271, RFC 6480, RFC 7567 and others

CS401N SIMULATION AND MODELLING (3-0-0) 3

Introduction to Modelling and simulation concepts. Levels of simulation for digital, analog & mixed mode circuits. IC CAD Overview. Device Simulation. Electrical simulation techniques. Relaxation based simulation

techniques. Gate level simulation, Switch level timing simulation. Mixed mode interface, Simulation and implementation, Analog multi-level simulation. Discrete time models, Event driven simulation, Logic simulation, Timing verification in ICs, Setup and hold times for clocked devices.

R. Saleh, S. Jou & A.R. Newton, Mixed mode simulation and analog multilevel simulation, Kluwer Academic Pub. 1994.
V.Litovski & M. Zwolinski, VLSI circuit simulation & Optimization, Chapman & Hall, 1997. J Baker, Li & Boyce, CMOS Circuit Design & Simulation, PHI, 2000

CS402N SOFTWARE TESTING (3-0-0) 3

Software testing concepts & principles, Testing strategies, Testability and related issues, Methods for developing the strategy, Life cycle testing, Installation phase testing and various phases of testing; Tools and techniques for software testing, Testing object oriented software, Testing in practice, State-of-art testing and bug detection techniques, Evaluating software quality, Test automation, Testers' workbench.

Ilene Burnstein, "Practical Software Testing", Springer Professional Computing, 2003. Glenford J. Myers, The Art of Software Testing, John Wiley & Sons, 1979
Cem Kaner, Jack Falk, Hung Quoc Nguyen, Testing Computer Software, 2nd Ed, Intl. Thomson Computer Press, 2008.
Ron Patton, "Software Testing", Second Edition, Sams Publishing, Pearson education, 2007.
Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill, 2004

CS403N WEB ENGINEERING (3-0-0) 3

Requirements specification and analysis, Web-based systems development methodologies and techniques, Migration of legacy systems to web environments, Web-based real-time applications development, Testing, Verification and validation, Quality assessment, Control and assurance, Configuration and project management, "Web metrics"- generating metrics for estimation of development efforts, Performance specification and evaluation, Update and maintenance, Development models, Teams, Staffing, Integration with legacy systems, Human and cultural aspects, User-centric development, User Modelling and user involvement and feedback, End-user application development.

Martin, Geert-Jan, Daniel, Bebo White, Journal of Web Engineering, Rinton Press, IEEE & ACM Publication, 2002.
Cato & John, User Centered web design, Pearson Education, 2001.
Kappel, G., Proll, B. Reich, S. & Retschitzegger, W. Web Engineering, 1s ed. Wiley & Sons.

CS404N DATA WAREHOUSING AND MINING (3-0-0) 3

Fundamentals of data warehousing, data warehouse components, data marts, metadata, data warehouse architecture, Extract, Transform and Load (ETL) concepts, processes and trends, ETL tools and techniques, challenges in ETL, data warehouse design, dimensional modelling, star schema, snowflake schema, fact constellation schema, OLAP and multidimensional data analysis, OLAP operations, OLAP queries, OLAP and decision support, indexing and query optimization. Data mining fundamentals, association rule mining, sequential pattern mining, classification and prediction, cluster analysis, outlier analysis, text mining, and applications of data mining.

Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011.
Pang-Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar, Introduction to Data Mining, 2nd Edition, Pearson, 2018.
Paulraj Ponniah, Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, 2nd Edition, Wiley, 2010.

Ralph Kimball and Margy Ross, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modelling, 3rd Edition, Wiley, 2013.
W. H. Inmon, Building the Data Warehouse, 4th Edition, Wiley, 2005.
Alex Berson and Stephen J. Smith, Data Warehousing, Data Mining, and OLAP, McGraw-Hill, 1997.
Anahory and Dennis Murray, Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems, Addison-Wesley, 1997.

CS405N PARALLEL PROGRAMMING (3-0-0) 3

Programming paradigms: Multithreaded parallel programming, Shared memory parallel programming, Message passing parallel programming, General purpose graphics processing units parallel programming, OpenCL, Many integrated core parallel programming. Important publications from literature

Bil Lewis, Daniel J Berg, Pthreads Primer – A guide to Multithreaded Programming. Prentice Hall. (SunSoft Press, 1996)
Barbara M Chapman, Using Open MP, The MIT Press, 2007.
William Gropp, Ewing Lusk, and Anthony Skjellum, Using MPI. 3e. The MIT Press. 2014. Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors: A Hands-on Approach, Morgann Kaufmann, 3e, 2016.
Rezaur Rahman, Intel Xeon Phi Coprocessor Architecture and Tools, Apress Open, 2013

CS406N TOPICS IN INFORMATION SECURITY (3-0-0) 3

Introduction of computer/information security, Design Principles, Access control matrix, Security policies, Confidentiality policies, Integrity policies, Integrity Model, Hybrid policies, Discretionary Access Control, Mandatory Access Control, Role-based access control and its variants, Attribute-based access control, Administrative model.

Matt Bishop, Computer Security: Art and Science, Addison Wesley, 2002.
Matt Bishop, Introduction to Computer Security, Addison Wesley, 2005.
C. Hu. Vincent, D. F. Ferraiolo, R. Kuhn, A. Schnitzer, K. Sandlin, R. Miller, and K. Scarfone. "Guide to attribute based access control definition and considerations," National Institute of Standards and Technology, 2014.

CS407N ALGORITHMIC GRAPH THEORY (3-0-0) 3

Graphs, Preliminaries on graphs, Cardinality matching in bipartite graphs, Weighted matching in bipartite graphs, Edmonds matching algorithm for general graphs, Algorithms for vertex cover in bipartite graphs. Flow networks, Ford-fulkerson algorithm, Dinitz algorithm, Application of flows, Connectivity, Structure of min-cuts, Algorithms for interval graphs, Chordal graphs, Tree-width, Algorithms based on tree-decompositions, Approximation algorithms, Parameterized algorithms, Exact exponential algorithms.

R. Diestel, Graph Theory, Second edition, Springer, 2000.
D. West, Introduction to Graph Theory, Second Edition, PHI, 2003.
J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, North Holland, 1976.
A. Schrijver, A course in Combinatorial Optimization, Cambridge University Press, 2004.
T.H Cormen, C.E Leiserson, R.L. Rivest, C. Stein, Introduction To Algorithms, Third edition, PHI, 2009.
J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education, 2006.

CS408N COMPUTATIONAL GEOMETRY (3-0-0) 3

Introduction: Historical perspective, Geometric preliminaries. Convex hulls algorithms in 2D and 3D, lower bounds. Triangulations: Polygon triangulations, Representations, Point-set triangulations. Voronoi diagrams: Algorithms, Closest pair problems. Delaunay triangulations: algorithms (divide-and-conquer, flip, incremental), Duality of voronoi diagrams, Properties (min-max angle). Geometric searching: Point-location, 2D linear programming with prune and search. Visibility: Algorithms for weak and strong visibility, Visibility with

reflections, Art-gallery problems. Arrangements of lines: 2D arrangements, zone theorem, Many-faces complexity, algorithms. Sweep techniques: Plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, Topological sweep for line arrangements. Combinatorial geometry: Ham-sandwich cuts, Helly's theorems, ksets. Rectilinear geometry: Intersection and union of rectangles, Rectangle searching. Robust geometric computing. Applications of computational geometry.

Mark de Berg, Otfried Schwarzkopf, Marc van Kreveld and Mark Overmars, Computational Geometry: Algorithms and Applications, Springer.
F. P. Preparata and Michael I. Shamos, Computational Geometry: An Introduction, Springer. Joseph O' Rourke, Computational Geometry in C, Cambridge University Press.
Lecture Notes by David Mount.

CS409N DEEP LEARNING (3-0-0) 3

Machine learning basics, Basic neural network models [McCulloch-Pitts Model of Neuron, Perceptron], Adaline, linear and non linear activation functions, loss functions, gradient descent method, back propagation algorithm, Deep feed forward networks, Regularization for deep learning, Convolutional neural networks, Optimization for training deep models, RNN, Autoencoders, Popular deep learning architectures published in the last 10 years, Limitations of CNN, Semi-supervised deep learning, Applications (image classification and segmentation).

Goodfellow, I., Bengio, Y., Courville, A. Deep learning (Vol. 1). Cambridge: MIT press.
Martin T hagan etc, Neural network design (2nd edition), 2014
Taqiq Rashid, Make your own Neural Network, 2016
Tom Mitchell, Machine Learning, McGraw-Hill, 1997
Y. S. Abu-Mostafa et.al , Learning from Data, AMLbook.com

CS410N COMPUTER VISION (3-0-0) 3

Introduction to computer vision, Image formation : Geometric primitives and transformation, Photometric image formation, Point operators, Linear filters, Fourier transform, Edge detection, Hough transform, Harris corner detector, HoG, SIFT, LBP, Texture, Segmentation, Feature based alignment, Structure from motion, Image stitching, Stereo Correspondence, Image based rendering, Object detection and recognition, Deep learning in computer vision, Applications.

David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson Education Ltd., 2015.
Richard Szeliski, Computer Vision: Algorithms and Applications,2010.
Goodfellow, I., Bengio, Y., Courville, A., Deep learning. Cambridge: MIT press, 2016
Aurelien Geron, Hands-On Machine Learning with Scikit-Learn & TensorFlow, SPD, 2017

CS411N SPEECH PROCESSING (3-0-0) 3

Mathematical foundations of signal processing, Speech production and perception, Speech signal analysis: Short time speech analysis, Time domain analysis, Frequency domain analysis, LPC (Linear predictive coding) analysis; Issues in speech processing: Speech synthesis, Speech recognition, Speaker identification, Emotion analysis, Language identification; Introduction to advanced topics in speech processing: Pattern classifiers.

Douglas O'Shaughnessy, Speech Communications Human and Machines (Second Edition) Rabiner and Juan., Fundamentals of speech recognition, 1999

CS412N NATURAL LANGUAGE PROCESSING (3-0-0) 3

Introduction to Natural Language Understanding, NLP tasks in Syntax, Semantics and Pragmatics, Text representation in computers, encoding schemes, Linguistics resources, Regular expressions, Finite State Automata, word recognition, lexicon, Morphology, acquisition models, Finite State Transducer, N-grams,

smoothing, entropy, HMM, ME, SVM, CRF, Stochastic POS tagging, HMM, Transformation based labelling (TBL), Handling of unknown words, named entities, multi word expressions, Parsing, Semantics, Word Sense Disambiguation, Discourse, Applications of NLP, Machine Translation.

1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009
2. James A.. Natural language Understanding 2e, Pearson Education, 1994
3. Bharati A., Sangal R., Chaitanya V. Natural language processing: a Paninian perspective, PHI, 2000
4. Siddiqui T., Tiwary U. S. Natural language processing and Information retrieval, OUP, 2008

CS413N REINFORCEMENT LEARNING (3-0-0) 3

Introduction and Basics of RL, Defining RL Framework and Markov Decision Process Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Tabular methods and Q-networks, Deep Q-networks, Policy optimization, Vanilla Policy Gradient Reinforce algorithm and stochastic policy search, Actor-critic methods, Advanced policy gradient, Model-based RL approach, Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL, Applying RL for real-world problems.

1. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
2. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds.
3. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
4. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

CS414N CLOUD SECURITY (3-0-0) 3

Modular arithmetic background, Concepts of security, How to assess security of a system, Information theoretic security v/s computational security, Data security and storage in cloud, Data dispersal techniques, High-availability and integrity layer for cloud storage, Encryption and key management in the cloud, Cloud forensics, Data location and availability, Data security tools and techniques for the cloud, Data distribution and information dispersal techniques Data encryption/decryption methodologies, Trustworthy cloud infrastructures, Cloud related regulatory and compliance issues.

Tim Mather, Subra Kumaraswamy, and Shahed Latif. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly.
Mather, T., Kumaraswamy S., and Latif, S. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance.
O'Reilly Media. Stallings, W. Cryptography and Network Security: Principles and Practice, 5th Edition. Prentice Hall.

CS415N CLOUD NETWORKING (3-0-0) 3

Data centers applications and their traffic patterns, Physical network structure, Cloud Topology, Data center network stack, Routing and switching for physical and virtual machines and congestion control, management and sharing of network infrastructure data centers, cloud networking ecosystem: inter-data center WAN connectivity, content distribution networks, end-user Internet connectivity, and application interactions with the network, Geo-distributed Cloud topology.

Cloud Native Data–Center Networking: Architecture, Protocols, and Tools, by Dinesh G. Dutt, Released November 2019, O'Reilly Media, Inc.
Cloud Data Center Network Architectures and Technologies, Lei Zhang, Le Chen, April 22, 2021 by CRC Press.

CS416N STORAGE SYSTEMS (3-0-0) 3

Storage System Components, Storage System Organization, Distributed File Systems, Network-Attached Storage, Cloud Storage, Big Data Storage, Data Protection, Disaster Recovery, High-Performance Parallel

File Systems, Virtualization, Decentralized storage, Multi-Device Arrays, Mirroring and RAID, SSD/HDD Hardware and Firmware, SSD/HDD Performance Enhancement File System and Database structures, Crash Recovery, Integrity Maintenance.

Gregory Ganger and Bruno V. Arlitt, Storage Systems: An Introduction to Storage Architecture and Technology, Morgan & Claypool Publishers, 2011.
Ulf Troppens, Rainer Erkens, Wolfgang Müller-Friedt, Rainer Wolafka and Nils Haustein, Storage Networks Explained: Basics and Application of Fibre Channel SAN, NAS, iSCSI, InfiniBand and FCoE, 2nd Edition, Wiley, 2009.
Marc Farley, Building Storage Networks, 2nd Edition, McGraw-Hill, 2001.
Tom Clark, Designing Storage Area Networks, 2nd Edition, Addison-Wesley Professional, 2003.
John G. Blazewicz, Klaus D. Meyer and others, Storage Systems: Organization, Performance, and Reliability, Springer.

CS417N NEXT GENERATION MULTI-CLOUD ARCHITECTURE (3-0-0) 3

Next Generation Cloud Computing, Modern Cloud Architectures, Challenges in Typical Cloud Architecture, Resource Relocation Technique (Virtual Machine and Container Migration), Federation Architectures, Container Management Techniques. Edge-Fog-Cloud architecture, Research and Development on Advanced Cloud Architectures (Serverless), Risk of deployment, Integration, Development and usage of LLMs in cloud.

Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey C. Fox, Morgan Kaufmann, ISBN: 9780128002049, December 2013
Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012
Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011

CS418N QUANTUM COMPUTER ARCHITECTURE (3-0-0) 3

Quantum Architecture and Hardware: Quantum Computing Overview, Classical Logic Gates and Circuits; Quantum Gates and Circuits. Quantum Building Blocks: Single-Qubit Quantum Systems, Multiple-Qubit Systems, Quantum State Transformations, Quantum Versions of Classical Computations. Quantum Algorithms: Computing with Superposition, Quantum Subroutines, Deutsch's Problem, Deutsch's-Jozsa Algorithm, Shor's Algorithm, Grover's Algorithm, etc. Robust Quantum Computer Architecture: Robust Quantum Stages, Fault Tolerance, Fault-Tolerant Using Steane's Code, Robust Computing Through Concatenated Coding, Classical Error Corrections, Quantum Error Corrections.

Quantum Computing, Eleanor Rieffel, Wolfgang Polak, The MIT Press, 1st Edn, 2011.
Quantum Computing, Bernhardt, Chris, MIT Press, 1st edn. 2019.
Quantum Computing Fundamentals, Chuck Easttom II, Pearson Education, 2021.
Quantum Computation and Quantum Information, M. Nielsen and I. Chuang, Cambridge University Press, 10th Edn. 2010.

CS419N WIRELESS NETWORKS (3-0-0) 3

Different types of wireless technologies such as: Cellular networks, Wi-Fi, Underwater acoustic networks. Different versions of 802.11 such as: Wireless access for vehicular environments, Gigabit Wi-Fi, and others. Rate adaptations algorithms such as: Auto rate fallback, Adaptive auto rate fallback, ONOE, Sample rate, Minstrel and others. Performance problems in wireless networks, Introduction to wireless TCP, Importance of explicit congestion notification in wireless networks. Different types of wireless routing protocols such as Ad hoc on demand distance vector, Ad hoc on demand multipath distance vector, Destination sequenced distance vector, Dynamic source routing and others.

Ilya Grigori, High Performance Browser Networking: What every web developer should know about networking and web performance. “O’Reilly Media, Inc.", 2013.
C. S. R. Murthy, Ad hoc wireless networks: Architectures and Protocols. Pearson Education India, 2004. Online Resources: Technical papers in course related topics and IEEE Standards documents.

CS420N MOBILE COMPUTING (3-0-0) 3

History and evolution of different generations of cellular networks, Radio propagation characteristics: Models for path loss, Shadowing and multipath fading, Jakes channel model, Digital modulation for mobile radio, Channel coding techniques, Multiple access techniques used in wireless mobile communications. Frequency reuse: The basic theory of hexagonal cell layout: Spectrum efficiency, FDM / TDM cellular systems: Channel allocation schemes, Handover analysis, Erlang capacity comparison of FDM / TDM systems and cellular CDMA. Discussion of GSM and CDMA cellular standards, Signaling and call control: Mobility management, location tracking. Wireless data networking, Packet error Modelling on fading channels, Performance analysis of link and transport layer protocols over wireless channels: Mobile data networking (Mobile IP), Use cases of SDN and NFV in Cellular Network Management.

Rappaport, T. S. Wireless Communications: Principles and Practice (Vol. 2). New Jersey: Prentice Hall PTR, 1996. Murthy, C. S. R. Ad hoc wireless networks: Architectures and Protocols. Pearson Education India, 2004. Kumar, A., Manjunath, D., & Kuri, J. Communication networking: an analytical approach. Elsevier, 2004.

CS421N OPEN SOURCE NETWORKING TECHNOLOGIES (3-0-0) 3

Introduction to Open Source Networking, Open Source and Software Defined Networking Landscape, Disaggregated Hardware, IO Abstraction and Datapath, Network Operating Systems, Network Control, Orchestration and Virtual Management, Network Virtualization, Network Function Virtualization, Network Automation, Network Data Analytics, Introduction to Linux Network Namespaces, Introduction to open source network simulators, Introduction to remote network testbeds.

Grigorik, Ilya. High Performance Browser Networking: What Every Web Developer Should Know About Networking and Web Performance, O'Reilly Media, Inc., 2017.
Goransson, P., Black, C., & Culver, T. Software defined networks: a comprehensive approach. Morgan Kaufmann, 2016.
Kurose, James F. Computer networking: A Top-Down Approach Featuring the Internet, 6/E. Pearson Education India, 2005/2016

CS450N HIGH PERFORMANCE COMPUTING (3-0-0) 3

Moore's law. Delay, Power, Energy, Temperature dependence in integrated circuits. Modern processor architecture: Instruction level parallelism: Pipelining hazards, Compiler techniques for ILP, Branch prediction, Static and Dynamic scheduling, Speculation, Limits of ILP. Memory systems: Multicore memory hierarchy: Cache tradeoffs, Basic and advanced optimizations, Virtual memory, DRAM optimizations. Parallelism: symmetric and distributed architectures, Cache coherence protocols - Snoopy and directory based, ISA support for synchronization, Parallelization basics, Basic optimizations on serial programs, Shared memory parallel programming, Distributed memory parallel programming, Heterogeneous parallel programming; Interconnection Networks: Architectures, Topologies, Performance, Routing, Flow control.

John Hennessy and David Patterson. Computer Architecture - A Quantitative Approach. 6ed. Morgan Kaufmann. 2018.
Smruti Ranjan Sarangi, Advanced Computer Architecture, McGraw Hill.
https://www.cse.iitd.ac.in/~srsarangi/advbook/index.html
Smruti Ranjan Sarangi, Next-Gen Computer Architecture: Till the End of Silicon, McGraw Hill. https://www.cse.iitd.ac.in/~srsarangi/advbook/index.html

John P. Shen and Mikko H. Lipasti. Modern Processor Design - Fundamentals of Superscalar Processors. Tata McGraw Hill.
William J Dally and Brian Towles. Principles and Practices of Interconnection Networks. Morgan Kaufmann. 2004.
Mark Hill/Margaret Martonosi (eds.). Synthesis Lectures on Computer Architecture, Morgan and Claypool, 2006 - - 2018.

CS451N NETWORK SECURITY (3-0-0) 3

Introduction to network security, Network security concepts, Attacks to networks and countermeasures, World wide web and internet security, Security protocols, Wireless security protocols, Intrusion detection and prevention systems, Organizational security issues, Security policies for network operations, Disaster recovery and business continuity.

Kaufman, Perlman and Speciner. Network Security: Private Communication in a Public World. Prentice Hall, 2nd edition. 2002.
Mark Ciampa, "Security+ Guide to Network Security Fundamentals", 2nd Edition, Cengage Learning, 2012.
William Stalling, Network Security Essentials - Applications and Standard, Pearson Education, 2004.

CS452N HETEROGENEOUS PARALLEL COMPUTING (3-0-0) 3

Graphics Processing Units: Architecture, Programming frameworks. General Purpose GPU programming. Xeon Phi: Architecture and Programming. Heterogeneous parallel algorithms and case studies. FPGA Computing – OneAPI and similar frameworks.

Wen Mei W Hwu, David B Kirk, Programming Massively Parallel Processors A Hands-on Approach, Morgan Kaufmann, 3e. December 2016
Rezaur Rahman, Intel Xeon Phi Coprocessor Architecture and Tools, Apress Open, 2013. Recent publications in IPDPS, PACT, and similar.

CS453N DISTRIBUTED DATABASE SYSTEMS (3-0-0) 3

Introduction, DDBMS architecture, DDBMS design, database integration, data and access control, distributed query processing, query decomposition and data localisation, optimization of distributed queries, multi-database query processing, transaction management, distributed concurrency control, distributed DBMS reliability, data replication, parallel database systems, and o peer-to-peer and web data management.

M.T. Ozsu and P. Valduriez, Principles of Distributed Database Systems, Third Edition, Springer-Verlag New York, 2011.
Ceri and Pelagatti, Distributed Database Principles and Systems, McGraw Hill. 2017
D. Bell and J. Grimson, Distributed Database Systems, Addison-Wesley, 1992.

CS454N SOCIAL NETWORK ANALYSIS (3-0-0) 3

Social web, statistical properties of social networks, graph theory, network analysis, concepts and measures, network dynamics and structural models, community detection, influence maximisation, link mining and link prediction, social network-based recommender systems, anomaly detection in social networks, mining discussion networks, visualising online social networks.

Mark Newman, Networks, 2nd Edition, Oxford University Press, 2018.
Stephen P. Borgatti, Martin G. Everett and Jeffrey C. Johnson, Analysing Social Networks, SAGE Publications, 2018.
Tanmoy Chakraborty, Social Network Analysis, Wiley, 2021.
Stanley Wasserman and Katherine Faust, Social Network Analysis: Methods and Applications, Cambridge University Press, 1994.

Charu C. Aggarwal, Social Network Data Analytics, Springer, 2014.
Reza Zafarani, Mohammad Ali Abbasi and Huan Liu, Social Media Mining: An Introduction, Cambridge University Press, 2014.

CS455N INFORMATION STORAGE MANAGEMENT (3-0-0) 3

Storage technology, challenges in data storage and data management, Core elements of a data center infrastructure, Storage system Architecture, integrated and modular storage systems, an intelligent storage system, networked storage, Monitoring and managing data centers, Storage security and storage visualization.

EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", Wiley, India, 2010
Marc Farley, —Building Storage Networks, Tata McGraw Hill, Osborne, 2001. Robert Spalding, —Storage Networks: The Complete Reference—, Tata McGraw Hill, Osborne, 2003

CS456N BLOCKCHAIN TECHNOLOGY (3-0-0) 3

Introduction and History, Brief Overview of Distributed System, Cryptography and Other Technical Foundations, The consensus layer and basic Properties, Byzantine Agreement, Proof of Work (PoW), Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS)Introduction to Blockchain, Applications of Blockchain technology, Case Study, Cryptocurrency basics, Transactions and Mining, Introduction to Smart Contracts, Privacy, Safety and Security Issues in Blockchain, Ethereum - Ethereum Virtual Machine (EVM) - Wallets for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts.

Roger Wattenhofer, The Science of the Blockchain, Inverted Forest Publishing, First Edition, 2016.
Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
Don Tapscott, Alex Tapscott, Blockchain Revolution: How the Technology behind Bitcoin and Other Cryptocurrencies is changing the World, Portfolio Penguin, 2018.
Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Bitcoin and Cryptocurrency Technologies - A Comprehensive Introduction, Princeton University Press, 2016.
Andreas M. Antonopoulos, Mastering Bitcoin: Programming The Open Blockchain, Shroff/O'Reilly, Second edition, 2017.

CS457N SOFTWARE BASED NETWORKS (3-0-0) 3

Traditional IP Control Plane and Router Implementation, History and Evolution of Software Defined Networking, Data and Control Plane Separation: Concepts, Advantages and Disadvantages, OpenFlow Protocol and Applications, Programmable Data Plane and Programmable Network Hardware, P4 Programming, SDN Controllers: ONOS, OpenDaylight and Floodlight, Network Function Virtualization: Network Middleboxes, Introduction to Virtualization: VMs and Containers, Introduction to Network Function Virtualization (NFV), Flow Tags, Function Placement, Routing and Service Function Chaining.

Goransson, P., Black, C., & Culver, T. Software defined networks: a comprehensive approach. Morgan Kaufmann, 2016.
Nadeau, T. D., & Gray, K. SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies. “O’Reilly Media, Inc.", 2013.
Gray, K., & Nadeau, T. D. Network function virtualization. Morgan Kaufmann, 2016.

CS458N DATABASE SECURITY (3-0-0) 3

Security architecture, Database Security, Operating system security, Application Security Models, Access Control models, Statistical DB security, Database auditing, Compliance Storage, Data Privacy, Steganographic File Systems, Privacy Preserving Data Mining, Database as a Service, Searchable encryption techniques.

Hassan A. Afyouni, "Database Security and Auditing", Third Edition, Cengage Learning, 2009. Alfred Basta, Melissa Zgola, Database Security, Cengage Learning, ISBN 1435453905, 2011
Charu C. Aggarwal, Philip S Yu, "Privacy Preserving Data Mining": Models and Algorithms, Kluwer Academic Publishers, 2008.
Ron Ben Natan, "Implementing Database Security and Auditing", Elsevier Digital Press, 2005. David C. Knox: Effective Oracle Database 10g Security by Design, McGraw-Hill, 2004.
Ron Ben-Natan, HOWTO Secure and Audit Oracle 10g and 11g, Publisher: Auerbach Publications; 1st edition (March 10, 2009)

CS459N INFORMATION CENTRIC NETWORKING (3-0-0) 3

Introduction to Information Centric Networking (ICN), Different types of ICN: NDN and CCN, Autonomous System (AS) Architecture and AS types, Domain Name System (DNS), Name resolution methods in ICN, Intra-AS routing protocols - Open Shortest Path First (OSPF), Intra-AS routing methods in ICN, Locating content and caching content, ICN applications: Case study.

Amin, K. Computational Intelligence for Security in Named Data Networking Lambert Academic Publishing, 2015. Ahmed, S. H., Bouk, S. H., Kim, D., & Sarkar, M. Bringing Named Data Networks into Smart Cities. Smart Cities: Foundations, Principles, and Applications, 275-309, 2017.

CS460N QUANTITATIVE COMPUTER ARCHITECTURE (3-0-0) 3

Instruction Level Parallelism. Branch prediction, Static and Dynamic Scheduling. Speculation. Multicore Memory Hierarchy: Cache trade-offs, Basic and Advanced optimizations, Virtual Memory, DRAM optimizations, Non-Volatile Memory. Multiprocessors: Symmetric and Distributed architectures, Cache coherence protocols, Memory Consistency Models. Hardware Accelerators. Secure processors

John Hennessy and David Patterson. Computer Architecture - A Quantitative Approach. 6ed or 5ed. Morgan Kaufmann, 2011
John P. Shen and Mikko H. Lipasti. Modern Processor Design - Fundamentals of Superscalar Processors. Tata McGraw Hill, 2010
William J Dally and Brian Towles. Principles and Practices of Interconnection Networks. Morgan Kaufmann. 2004. Mark Hill/Margaret Martonosi (eds.). Synthesis Lectures on Computer Architecture, Morgan and Claypool, 2006 -- 2018.

CS461N COMPUTATIONAL DISCRETE GEOMETRY (3-0-0) 3

Affine and Convex Geometry: affine space, affine dependence and affine hull, convex combinations and convex hulls, Radon's theorem, Helly's theorem, Carathéodory's theorem, the infinite Helly theorem, centerpoints, Rado's centerpoint theorem, Jung's theorem, separation theorems, and covering, intersecting, and hitting by translates. Geometric Structures and Algorithms: convex hulls, Voronoi diagrams, Delaunay triangulations, lifting transformation, randomized incremental construction, convex hull algorithms, applications of Voronoi diagrams, zone theorem, polygon triangulation, and art gallery theorem. Extremal and Incidence Geometry: Erdős–Szekeres theorem, Sylvester–Gallai theorem, crossing lemma, Kővári–Sós–Turán theorem, point-line incidences, Szemerédi–Trotter theorem, heavy lines, sum-product estimates, distance distribution, unit-distance problem, and distinct-distances problem. Combinatorial Complexity and Duality: point-line duality, Davenport–Schinzel sequences, arrangements of lines and hyperplanes, levels in arrangements, and combinatorial complexity of geometric structures. Topological and Colorful Methods: Borsuk–Ulam theorem, ham-sandwich theorem, colorful Carathéodory theorem, Tverberg's theorem, and geometric partitioning. Set Systems and Combinatorial Geometry: set systems, transversals, packing and matching numbers, VC-dimension, shattering, Sauer–Shelah lemma, and ε-net theorem. Probabilistic and High-Dimensional Geometry: probabilistic methods, Johnson–Lindenstrauss lemma, Gaussian annulus theorem, concentration of measure, and dimension reduction. Further Topics in Discrete Geometry: Erdős–Ko–Rado theorem, convex

polytopes, upper bounds on the number of vertices of convex polytopes, combinatorial properties of polytopes, and selected advanced topics from current research in discrete and combinatorial geometry.

J. Matoušek, Lectures on Discrete Geometry, Springer, 2002.
J. Pach and P. K. Agarwal, Combinatorial Geometry, Wiley-Interscience, 1995.
Mark de Berg, Otfried Schwarzkopf, Marc van Kreveld and Mark Overmars, Computational Geometry: Algorithms and Applications, Springer.S.
Har-Peled, Geometric Approximation Algorithms, American Mathematical Society, 2011.
M. Sharir and P. K. Agarwal, Davenport-Schinzel Sequences and Their Geometric Applications, Cambridge University Press, 2000.G.
M. Ziegler, Lectures on Polytopes, Springer, 1995.
N. Alon and J. Spencer, The Probabilistic Method, 4/e, Wiley, 2016.M.
Mitzenmacher and E. Upfal, Probability and Computing, Cambridge University Press, 2005.

CS398N/ CS448N/ CS498N INTERNSHIP – I/ II/ III **(0-0-18) 9**

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

CS399N MAJOR PROJECT - I **(0-0-18) 9**

CS449N MAJOR PROJECT - II **(0-0-18) 9**

CS499N MAJOR PROJECT - III **(0-0-18) 9**

Department of Electrical and Electronics Engineering (EE)
Bachelor of Technology in Electrical and Electronics Engineering

Basic Science Courses (BSC)

PH150N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
MA107N	Multivariable Calculus	(3-0-0)3
MA108N	Applied Linear Algebra and Graph Theory	(3-0-0)3
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

UC101N	Introduction to Engineering	(2-0-2)3
CS101N	Computer Programming (Python)	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC)

EE201N	Circuit Theory	(2-1-0)3
EE203N	Signals and Systems	(2-1-0)3
EE205N	Digital Electronics	(2-1-0)3
EE207N	Mathematics for Electrical Engineers	(2-1-0)3
EE202N	Circuit Theory Lab	(0-0-4)2
EE204N	Signals and Systems Lab	(0-0-4)2
EE206N	Digital Electronics Lab	(0-0-4)2
EE251N	Electrical Machines-1	(2-1-0)3
EE253N	Control Systems	(2-1-0)3
EE255N	Analog Electronics	(2-1-0)3
EE257N	Digital Signal Processing	(2-1-0)3
EE252N	Electrical Machines-1 Lab	(0-0-4)2
EE254N	Control Systems Lab	(0-0-4)2
EE256N	Analog Electronics Lab	(0-0-4)2
EE301N	Power Electronics	(2-1-0)3
EE303N	Power Systems	(2-1-0)3
EE305N	Electrical Machines-2	(2-1-0)3
EE302N	Power Electronics Lab	(0-0-4)2
EE304N	Power Systems Lab	(0-0-4)2
EE306N	Electrical Machines-2 Lab	(0-0-4)2

Dept./Institute Elective Courses (DEC)

EE351N	C Programming for Electrical Engineers	(2-0-2)3
EE352N	Renewable Energy Systems	(3-0-0)3
EE353N	Embedded System Design	(2-0-2)3
EE354N	Electromagnetic Theory	(3-0-0)3
EE355N	Fundamentals of Electric Vehicles	(3-0-0)3
EE356N	Digital Systems Design	(2-0-2)3
EE357N	Digital Computer Organisation and Architecture	(3-0-0)3
EE358N	Computer Networks	(3-0-0)3
EE359N	Sensors and Actuators	(2-0-2)3
EE360N	Industrial Process Automation	(3-0-0)3
EE361N	Probability and Stochastic Processes	(3-0-0)3
EE362N	Machine Learning	(2-0-2)3
EE363N	Electric Drives	(2-1-0)3
EE364N	Computer-Aided Analysis of Large Power Systems	(2-1-0)3
EE365N	Electrical and Electronics Measuring Instruments and Techniques	(2-1-0)3
EE401N	High Voltage Engineering	(3-0-0)3
EE402N	Principles of Switchgear and Protection	(2-0-2)3
EE403N	Power Generation and Economics	(3-0-0)3
EE404N	Power Quality	(3-0-0)3
EE405N	Smart Grid Technologies	(3-0-0)3
EE406N	Basic Design of Rotating Electrical Machines	(3-0-0)3
EE407N	Introduction to Modelling of Electrical Machines	(3-0-0)3
EE408N	Advanced Power Electronics	(3-0-0)3
EE409N	Nonlinear and Optimal Control	(3-0-0)3
EE410N	Robot Modelling and Control	(2-0-2)3
EE411N	Deep Neural Networks	(2-0-2)3
EE412N	Time Series Analysis and Forecasting	(2-1-0)3
EE413N	AI-Driven IoT Systems	(2-0-2)3
EE415N	Electric Power System	(2-1-0)3
EE451N	Flexible AC Transmission Systems	(3-0-0)3
EE452N	Power Electronics for HVDC and FACTS Applications	(3-0-0)3
EE453N	Simulation and Control of Power Electronic Converters	(2-0-2)3
EE454N	High Power Converters for Electrical Drives	(3-0-0)3
EE455N	Power Converters for EV Charging	(2-1-0)3
EE456N	Power Electronics in Power Control	(2-1-0)3

Internship / Major Project Courses (IPC)

EE398N	Internship I	(0-0-18)9
EE399N	Major Project I	(0-0-18)9
EE448N	Internship II	(0-0-18)9
EE449N	Major Project II	(0-0-18)9
EE498N	Internship III	(0-0-18)9
EE499N	Major Project III	(0-0-18)9

Honors Courses

Students seeking the Honors degree shall credit a minimum of 15 additional credits from Postgraduate courses offered by the Department of Electrical and Electronics Engineering, as decided by the DUGC.

Suggested Plan of Study for B.Tech. in Electrical and Electronics Engineering:

Slot/ Semester	I	II	III	IV	V	VI	VII	VIII
1	CY100N	PH150N	EE201N	EE251N	EE301N	EE398N / EE399N	EE448N / EE449N	EE498N / EE499N
2	MA107N	MA108N	EE203N	EE253N	EE303N	DEC 1	DEC 4	DEC 6
3	UC100N	UC102N	EE207N	EE255N	EE305N	DEC 2	DEC 5	DEC 7
4	DE100N	UC101N	EE205N	EE257N	EE302N	DEC 3	Honors / Minor (Optional)	Honors / Minor (Optional)
5	UC103N	CS101N	EE202N	EE252N	EE304N	Honors / Minor (Optional)		
6	PL1XWN / PL1X9N	PL1YWN / PL1Y9N	EE204N	EE254N	EE306N			
7			EE206N	EE256N	Honors / Minor (Optional)			
8			PL2XWN / PL2X9N	Honors / Minor (Optional)	PL3XWN / PL3X9N			
9				PL2YWN / PL2Y9N				

Requirements for B.Tech. in Electrical and Electronics Engineering:

Category of Courses	Minimum Credits to be Earned
Basic Sciences Courses (BSC): 20 General Engineering Courses (GEC): 12	32
Programme Core Courses (PCC)	51
Dept./Institute Elective Courses (DEC)	21
Internships / Major Project Courses (IPC)	27
Life Skill Courses (LSC)	20
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

EE201N CIRCUIT THEORY (2-1-0) 3

Introduction to circuit elements, Ohm's Law, Ideal and practical voltage & current source, OC and SC conditions, Independent and dependent sources, V-I characteristics, KVL, KCL, series and parallel combinations, voltage and current division, Source transformations, star-delta transformation, examples. Mesh analysis, nodal analysis & super-mesh concepts in DC circuit with dependent & independent sources, examples. Super-node concepts in DC circuits with dependent & independent sources, Inductor and Capacitor elements, Superposition in DC circuits, examples. Thevenin, Norton & Millman theorems in DC circuits, examples. Maximum power transfer theorem in DC circuits, Concept of transients in electrical circuits, response of R-L circuit, examples. Response of R-C circuit, Definition and physical significance of time constant, Initial and final conditions in first-order circuits, Introduction to second-order (RLC) circuits, Overdamped, Critically damped and Underdamped systems, Natural frequency and damping ratio, Physical interpretation of different damping conditions. Introduction to magnetic circuits, MMF, reluctance, flux, series and parallel paths, Self and mutual inductance, coupling, dot convention, equivalent inductance, examples. Generation of 1-phase AC generation, definition of various terms associated with 1-phase AC, average and RMS values, form factor, Concept of Phasors, phase & phase difference, phasor diagram. Behaviour of circuit elements with AC for R, L, C, R-L, impedance and admittance, phasor diagrams, active power, reactive power, apparent power, impedance and power triangle. Behaviour of circuit elements with AC for R-C & R-L-C circuits, impedance and admittance, phasor diagrams, active power, reactive power, apparent power, impedance and power triangle. Power factor improvement in AC circuits, Mesh, nodal, super-mesh, super-node analysis in AC circuits, Superposition, Thevenin, Norton, Millman, Maximum power transfer theorems in AC circuits, examples. Three-phase balanced systems, star/delta connections, power, two-wattmeter method. Introduction to unbalanced loads, Series and parallel resonance, Quality factor, and bandwidth.

Textbooks: Alexander, Charles K., and Matthew Sadiku. Fundamentals of electric circuits. Qinghua University Press, 2000.
D. P. Kothari and I J Nagrath. Basic Electrical Engineering, Tata McGraw Hill, Third Edition.
Edward Hughes – Electrical technology (Ed-7) Longman, 1995.
William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, 6th Edition, TMH, 2002.
H. Cotton, Advanced Electrical technology, Wheeler, 1983.
V. Del Toro, "Electrical Engineering Fundamentals", 2nd Edition, Pearson Education.
Handbooks: Harish C. Rai & Shivanshu Rai, Handbook of Basic Electrical Engineering Formulae.
Wai-kai Chen, The Electrical Engineering Handbook, CRC Press.
SWAYAM: Basic Electrical Circuits, Prof. Gajendranath Chowdary, IIT Madras, https://nptel.ac.in/courses/117106108
Basic Electrical Circuits, Dr. Nagendra Krishnapura, IIT Madras, https://nptel.ac.in/courses/108106172

EE203N SIGNALS AND SYSTEMS (2-1-0) 3

Classification of continuous-time and discrete-time signals, signal operations, linearity, time invariance, causality, and stability. Time-domain representation of continuous-time signals, impulse and step response of continuous-time LTI systems. Convolution integral, properties of convolution. Time-domain analysis of continuous-time systems. Fourier series representation of periodic signals, trigonometric and exponential Fourier series. Fourier transform of continuous-time signals, frequency-domain system analysis, and applications. Representation of discrete-time signals, impulse and step response of discrete-time systems. Convolution sum, properties of discrete-time LTI systems, and response analysis. Sampling theorem, signal reconstruction, Spectral Sampling. Discrete-Time Fourier Series (DTFS), properties, and applications. Discrete-Time Fourier Transform (DTFT), frequency-domain interpretation, and system analysis. Laplace transform and its properties, region of convergence, solution of differential equations, and transfer-function-based system analysis. Z-transform and its properties, region of convergence, solution of difference equations, and stability analysis. Comparative analysis of continuous-time and discrete-time system representations,

frequency response and stability concepts, and application-oriented problem solving using Fourier, Laplace, and Z-transform techniques.

Textbooks: B. P. Lathi, Linear Systems and Signals, 1st / 2nd Edition, Oxford University Press, 2005.
A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, Signals and Systems, 2nd Edition, Prentice-Hall Signal Processing Series, 1997.
Handbooks: Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley & Sons, Inc.
SWAYAM: Prof. Aditya Jagannatham, Principles of Signals and Systems, NPTEL, IIT Kanpur, https://nptel.ac.in/courses/108104100

EE205N DIGITAL ELECTRONICS (2-1-0) 3

Number systems, conversions, binary arithmetic, 1's & 2's complement, fixed point and floating-point representation. Logic gates, Boolean algebra, De Morgan's theorems. Boolean expression simplification, canonical forms. K-maps (2–4 variables), don't-care conditions. Adders, subtractors, multiplexers, decoders, encoders. Code converters, parity generators/checkers, logic synthesis applications. Latches, SR, JK flip-flops, characteristic and excitation tables. D & T flip-flops, flip-flop conversions, timing parameters. Counters (sync/async), shift registers, timing analysis. FSM concepts, state diagrams, Mealy and Moore models. FSM design using D flip-flops, state reduction, applications. Sequence detectors and generators, system-level digital design. FSM case studies, hazards, races, timing considerations. Data converters: DAC, ADC, Sample-and-Hold circuits.

Textbooks: M. M. Mano and M. D. Ciletti, Digital Design, 5th ed. Upper Saddle River, NJ, USA: Pearson, 2012.
D. P. Leach and A. P. Malvino, Digital Principles and Applications, 7th ed. New York, NY, USA: McGraw-Hill, 2006.
J. F. Wakerly, "Digital Design Principles and Practices", Practice Hall.
Handbooks: Donald D. Givone, "Digital Principles and Design," McGraw Hill.
Ronald J. Tocci, "Digital Systems: Principles and Applications," 11th Edition, Pearson.
SWAYAM: Goutam Saha, Digital Electronic Circuits, NPTEL, IIT Kharagpur,
https://nptel.ac.in/courses/108105132
Santanu Chattopadhyay Digital Circuits, NPTEL, IIT Kharagpur https://nptel.ac.in/courses/108105113

EE207N MATHEMATICS FOR ELECTRICAL ENGINEERS (2-1-0) 3

Introduction to Iterative Methods for Linear Equations, Jacobi & Gauss–Seidel method, Convergence criteria, Diagonal dominance, Matrix Inversion, Condition Number, Ill-conditioned systems, examples. Errors in Numerical Computation: Types of errors: truncation, round-off, Absolute, relative, & percentage errors, Propagation of errors, Significant digits & numerical stability, examples. Introduction to nonlinear equations, Graphical, Bisection, Regula-Falsi, Fixed-point iteration, Newton–Raphson, & Secant method, Convergence analysis & comparison of methods, examples. Introduction to Numerical Solution of Ordinary Differential Equations, Taylor series method, Euler method, Modified Euler method, examples. 2nd order Runge–Kutta method and 4th order Runge–Kutta method and comparison of methods, examples. Introduction to Optimization, Classification: Static vs dynamic, Deterministic vs stochastic, Linear vs nonlinear, Continuous vs discrete. vectors, norms, matrices, convex sets and convex functions. Introduction to Unconstrained Optimization, level sets, gradients, optimality conditions, Local & global minima, First-order & second-order necessary and sufficient conditions, examples. Mathematical formulation of Steepest descent method, advantages, disadvantages, examples. Mathematical formulation of Newton's method, advantages, disadvantages, examples. Introduction to constrained Optimization, Equality and inequality constraints, Significance of Lagrange multiplier, examples. Optimality conditions, Lagrange multiplier method, Karush–Kuhn–Tucker (KKT) conditions, examples. Linear Programming: standard form, unrestricted variables, slack and surplus variables, artificial variables, Formulation of linear programming problems, examples. Graphical solution method and analytical solution of linear programming problems, examples. Simplex method for linear programming problems, examples.

Textbooks: Steven C. Chapra, R. P. Canale, Numerical Techniques for Engineers, TMH, 2000.
David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 3rd Edition, Springer, 2008.
Fletcher R., Practical Methods of Optimization, John Wiley, 2000.
S. S. Rao, Engineering Optimization: Theory and practice, New Age International publishers.
Handbooks: Philippe G. Ciarlet, Jacques-Louis Lions, et al., Handbook of Numerical Analysis.
Ivan Zelinka, Václav Snášel, and Ajith Abraham, Handbook of Optimization: From Classical to Modern Approach.
SWAYAM: Numerical Optimization, Dr. Shirish K. Shevade, IISc Bangalore,
https://nptel.ac.in/courses/106108056,
Numerical Methods, Prof. Ameeya Kumar Nayak Prof. Sanjeev Kumar, IIT Roorkee,
https://nptel.ac.in/courses/111107105

EE202N CIRCUIT THEORY LAB (0-0-4) 2

Verification of Superposition and Thevenin Theorems in DC circuits using hardware experiments and simulation. Verification of Norton's, and Maximum Power Transfer Theorems in DC circuits using hardware experiments and simulation. DC transient response analysis of RC circuit with analytical, experimental, and simulation-based validation. DC transient response analysis of RL circuit with analytical, experimental, and simulation-based validation. DC transient response analysis of RLC circuit with analytical, experimental, and simulation-based validation. Verification of Thevenin and Norton's Theorems in AC circuits using hardware experiments and simulation. Analysis of voltage, current and Power factor in single-phase AC circuits (R, L, C, RL, RC, RLC) and validation using simulation tools. Three phase power measurement using Wattmeter. Analysis and verification of power (active, reactive, and apparent) in single-phase AC circuits through experimental and/or simulation methods. Analysis of resonance behaviour in series RLC circuits through experimental and/or simulation methods. Experimentally analyze domestic electrical wiring by connecting and operating lamps using switches and to understand the working, control, and safety aspects of household electrical installations. Experimentally analyze the earthing system and study the operation and protective role of electrical safety devices such as fuses and Miniature Circuit Breakers (MCBs) used in domestic electrical installations. etc.

Textbooks: Alexander, Charles K., and Matthew Sadiku. Fundamentals of electric circuits. Qinghua University Press, 2000.
D. P. Kothari and I J Nagrath. Basic Electrical Engineering, Tata McGraw Hill, Third Edition.
Edward Hughes – Electrical technology (Ed-7) Longman, 1995.
William H. Hayt Jr., Jack E. Kemmerly, Steven M.Durbin, Engineering Circuit Analysis, 6th Edition, TMH, 2002.
Handbooks: Harish C. Rai & Shivanshu Rai, Handbook of Basic Electrical Engineering Formulae.
Wai-kai Chen, The Electrical Engineering Handbook, CRC Press.
SWAYAM: Basic Electrical Circuits, Prof. Gajendranath Chowdary, IIT Madras,
https://nptel.ac.in/courses/117106108
Basic Electrical Circuits, Dr. Nagendra Krishnapura, IIT Madras, https://nptel.ac.in/courses/108106172

EE204N SIGNALS AND SYSTEMS LAB (0-0-4) 2

Introduction to Computing Environment and Basic Computational Operations. Advanced Vector, Matrix Manipulation, and Script Development in Technical computational tools. Representation of Continuous-Time and Discrete-Time Signals using Technical Computing Tools.

of Exponential and Damped Sinusoidal Signals and Basic Signal Operations. Numerical Integration and Computation of Signal Energy and Power. Solution of Continuous-Time Differential Equations using Technical Computing Tools. Solution of Discrete-Time Difference Equations and System Responses. Impulse Response Analysis and Graphical Interpretation of Convolution. Fourier Series Analysis of Periodic Signals using Technical Computing Tools. Sampling Theorem and Signal Reconstruction sing Technical Computing Tools.

Fourier Transform and Discrete Fourier Transform (DFT) Analysis. Comparison of Fourier Transform and Discrete Fourier Transform for Signal Analysis.

Textbooks: B. P. Lathi, Linear Systems and Signals, 1st / 2nd Edition, Oxford University Press, 2005.
A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, Signals and Systems, 2nd Edition, Prentice-Hall Signal Processing Series, 1997.
Handbooks: Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley & Sons, Inc.
SWAYAM: Prof. Aditya Jagannatham, Principles of Signals and Systems, NPTEL, IIT Kanpur, https://nptel.ac.in/courses/108104100

EE206N DIGITAL ELECTRONICS LAB (0-0-4) 2

Study and verification of basic logic gates (AND, OR, NOT, NAND, NOR, XOR). Realization of logic gates using universal gates (NAND & NOR). Implementation and verification of half adder and full adder. Design and implementation of binary subtractor and adder–subtractor. Design of 8-bit binary adder and magnitude comparator. Realization of different code converters (Binary–Gray, Gray–Binary, BCD–Excess-3. Implementation and verification of multiplexer, demultiplexer, encoder and decoder. Construction of SR, JK flip-flops using logic gates and verification. Design and verification of D and T flip-flops; flip-flop conversions. Design and verification of shift registers (SISO, SIPO, PISO, PIPO). Design and implementation of counters (asynchronous and synchronous). Experiment on DAC, ADC and Sample-and-Hold Circuit Characteristic.

Textbooks: M. M. Mano and M. D. Ciletti, Digital Design, 5th ed. Upper Saddle River, NJ, USA: Pearson, 2012.
D. P. Leach and A. P. Malvino, Digital Principles and Applications, 7th ed. New York, NY, USA: McGraw-Hill, 2006.
J. F. Wakerly, "Digital Design Principles and Practices", Practice Hall.
Handbooks: Donald D. Givone, "Digital Principles and Design," McGraw Hill
Ronald J. Tocci, "Digital Systems: Principles and Applications," 11th Edition, Pearson
SWAYAM: Goutam Saha, Digital Electronic Circuits, NPTEL, IIT Kharagpur
https://nptel.ac.in/courses/108105132
Santanu Chattopadhyay Digital Circuits, NPTEL, IIT Kharagpur [https://nptel.ac.in/courses/108105113

EE251N ELECTRICAL MACHINES-1 (2-1-0) 3

Principles of energy conversion, Review of Faraday's laws: production of induced voltage and induced force. Transformers: Working principle, types and construction, EMF equation. Ideal transformer and circuit model, voltage/current/impedance transformations. per-unit system. Practical transformer and circuit model, phasor diagrams. Transformer losses, testing (OC and SC tests, Sumpner's test), voltage regulation. Transformer efficiency, all-day efficiency, parallel operation, Inrush current, Autotransformer, Three-phase transformers: various types/connections, vector groups. Instrument transformers. Three-phase induction motor: types and construction, working principle. Induction motor equivalent circuit and analysis, power flow. Torque and power expressions, Condition for maximum torque, Starting torque. Induction motor torque-speed characteristics, performance analysis, no-load and blocked-rotor tests. Induction motor starting methods and speed control, wound rotor induction motor and effects of rotor resistance. Single-phase induction motor: types, working principle, applications. Induction generator, Universal motors.

Textbooks: A. E. Fitzgerald, Charles Kingsley Jr. and Stephen D Umans, Electric Machinery, McGraw Hill, Sixth Edition, 2003.
Stephen. J. Chapman, Electric Machinery Fundamentals, 5th ed. New York, NY, USA: McGraw-Hill Education, 2012.
Handbooks: M.G. Say, "The Performance and Design of Alternating Current Machines", CBS Publishers, 1983.
D.P. Kothari and I.J. Nagrath, "Electric Machines," Tata McGraw Hill Education, Fourth Edition, 2010.
SWAYAM: Prof. G. Bhuvaneshwari, "Electrical Machines", IIT Delhi.
https://onlinecourses.nptel.ac.in/noc21_ee24/preview

Prof. Tapas Kumar Bhattacharya, "Electrical Machines – I", IIT Kharagpur., https://onlinecourses.nptel.ac.in/noc25_ee124/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – II", IIT Kharagpur., https://onlinecourses.nptel.ac.in/noc23_ee55/preview
Dr. A. Venkadesan, "Induction, Synchronous and Special Electrical Machines", NIT Puducherry., https://onlinecourses.swayam2.ac.in/ntr25_ed135/preview

EE253N CONTROL SYSTEMS (2-1-0) 3

Control systems overview, open and closed loop systems, components, real-world applications. Block diagrams, signal flow graphs, mathematical modelling in time and frequency domains. Time-domain response, performance specifications, transient and steady-state behaviour. Performance improvement techniques, stability concepts, Routh–Hurwitz stability criterion. Root locus concept, construction rules, system stability interpretation. Frequency response analysis, Bode plots, bandwidth, resonant peak. Gain margin, phase margin, Nyquist plots, stability criterion. Controller design using root locus, lead and lag compensation principles. Controller design using frequency response methods, lead and lag compensation. Comparative analysis of root locus and frequency response–based controller design techniques. State-space modelling, solution of state equations, controllability and observability. State feedback control concepts and controller design objectives. Pole placement using Ackermann's formula and state feedback design examples. Comparison of state-space and transfer function pole placement methods, advantages, limitations, design insights.

Textbooks: Norman S. Nise, "Control Systems Engineering", 5th Edition, John Wiley & Sons, Inc., 2008.
Ogata K., Modern Control Engineering, 5th edition, Prentice Hall, 2010
C. T. Chen, Analog Digital Control System Design, Harcourt College Pub
Handbooks: Khalil H.K., Nonlinear Systems, 3rd edition, Prentice Hall, 2002.
M. Gopal, "Control Systems: Principles and Design", 4th edition, Mcgraw Higher Ed, 2012.
SWAYAM: R. Pasumarthy and M. Mukherjee, Control Engineering, NPTEL, IIT Madras & IIEST Shibpur., https://onlinecourses.nptel.ac.in/noc26_ee68/preview
C.S. Shankar Ram, Control Systems, NPTEL, Indian Institute of Technology Madras, https://nptel.ac.in/courses/107106081

EE255N ANALOG ELECTRONICS (2-1-0) 3

Semiconductor fundamentals: intrinsic/extrinsic, conductivity, P–N junction diode, diode applications. BJT configurations: NPN/PNP, CE, CB, CC; input–output characteristics. BJT biasing techniques: fixed bias, voltage divider, emitter-stabilized circuits. Small-signal models: hybrid-π and T-models, parameter extraction. BJT circuit analysis and amplifier applications. JFET and MOSFET construction, characteristics, biasing techniques. Small-signal MOSFET models, MOSFET as switch, introduction to CMOS. Ideal vs practical op-amp characteristics; inverting, non-inverting, summing amplifiers. Integrators, differentiators, feedback amplifiers, differential and instrumentation amplifiers. Non-linear op-amp applications: comparators, Schmitt triggers, precision rectifiers. Oscillators: RC, LC, crystal oscillators; Barkhausen criterion. Linear regulators: 78XX/79XX, LDOs, stability, PSRR, bandwidth. Frequency response of amplifiers, bandwidth, gain–bandwidth tradeoff. Waveform generation and active filters: low-pass, high-pass, band-pass.

Textbooks: A. S. Sedra and K. C. Smith, Microelectronic Circuits, 7th Edition, Oxford University Press, 2014
R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th Edition, Pearson, 2013
Handbooks: Horowitz and W. Hill, The Art of Electronics, 3rd Edition, Cambridge University Press, 2015.
S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, McGraw-Hill Education, 2014
SWAYAM: Pradip Mandal, Analog Electronic Circuits - NPTEL IITKGP, Available: https://onlinecourses.nptel.ac.in/noc25_ee157/preview

EE257N DIGITAL SIGNAL PROCESSING (2-1-0) 3

Introduction– Definitions, frequency in continuous and discrete time signal. Review of Fourier Transforms – specific focus on DTFS and DTFT. Uniform Sampling– Sampling in time domain, sampling theorem. Reconstruction using ideal interpolation. Frequency Domain Sampling and Reconstruction – DFT from DTFT, frequency domain sampling, aliasing, frequency resolution. DFT as a linear transformation, inverse DFT. Convolution– Linear and circular convolution, circular shift, circular symmetry. Properties of DFT – Linearity, periodicity, symmetry, circular convolution, circular time shift, circular frequency shift. Linear Convolution and DFT– Efficient implementations of convolution. More on DFT – Spectral leakage, time-domain windowing. Fast Fourier Transform– Radix-2 FFT algorithm, FFT algorithms - DIT, DIF. Filters Design – Introduction, specifications of practical filters, a review of the z-transform. Analog Filters – Butterworth filters, Chebyshev's filters (LP, HP, BP, BS). Frequency Transformation and the Design of Digital IIR Filters– IIR filters, impulse invariant method, bilinear transformation. FIR Filters– Frequency sampling method, design using Rectangular, Hamming, Hanning, Kaiser windows. Digital Filter Structures/Realization– Direct form, cascade form, parallel form, ladder form.

Textbooks: 1. Proakis J. G. and Manolakis D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", Prentice Hall, 1996.
2. Oppenheim A.V. and Schafer R.W., "Discrete-Time Signal Processing", Prentice-Hall, 2009.
Handbooks: Ramesh Babu P., "Digital Signal Processing", 6th edition, Scitech Publications (India), 2015.
Mitra S.K., "Digital Signal Processing, A Computer-Based Approach", McGraw Hill, 2002.
SWAYAM: Prof. V. M. Gadre, "Digital Signal Processing and its Applications", IIT Bombay, https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee20
Prof. C. S. Ramalingam, ""Digital Signal Processing", IIT Madras, https://nptel.ac.in/courses/108106151

EE252N ELECTRICAL MACHINES-1 LAB (0-0-4) 2

Introduction to transformers and induction motor Lab. OC and SC tests on a single-phase transformer, and predetermination of efficiency and voltage regulation. Sumpner's test on single-phase transformers. Load test and voltage regulation of a single-phase transformer. Scott connection of transformers. Experimental Study of Three-Phase Transformer Connections (Y–Y, Y–Δ, Δ–Y, Δ–Δ and Open-Delta). Parallel operation of single-phase transformer. No-load and blocked-rotor tests on a three-phase induction motor. Load test on a three-phase induction motor. Speed control of a three-phase slip-ring induction motor. Load test on a single-phase induction motor. Speed control of inverter fed induction motor.

Textbooks: A. E. Fitzgerald, Charles Kingsley Jr. and Stephen D Umans, Electric Machinery, McGraw Hill, Sixth Edition, 2003.
Stephen. J. Chapman, Electric Machinery Fundamentals, 5th ed. New York, NY, USA: McGraw-Hill Education, 2012.
Handbooks: M.G. Say, "The Performance and Design of Alternating Current Machines", CBS Publishers, 1983.
D.P. Kothari and I.J. Nagrath, "Electric Machines," Tata McGraw Hill Education, Fourth Edition, 2010.
SWAYAM: Prof. G.Bhuvaneshwari, "Electrical Machines", IIT Delhi.
https://onlinecourses.nptel.ac.in/noc21_ee24/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – I", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc25_ee124/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – II", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc23_ee55/preview
Dr. A. Venkadesan, "Induction, Synchronous and Special Electrical Machines", NIT Puducherry., https://onlinecourses.swayam2.ac.in/ntr25_ed135/preview

EE254N CONTROL SYSTEMS LAB (0-0-4) 2

Introduction to Control System Toolbox for representation and simulation of LTI systems. Plot and interpret step and impulse responses of basic transfer function models. Study on interconnection of control systems in

series, parallel, and feedback configurations. Analysis of the effect of feedback on closed-loop system performance using simulations. Development of mathematical models of dynamic systems using the state-space approach. Simulation of state responses and compare state-space and transfer function representations. Analysis of time-domain response of first-order systems using simulation and hardware setup. Evaluation of transient and steady-state performance parameters. Analysis of time-domain response of second-order systems using simulations and hardware setup. Measurement of rise time, peak time, overshoot, and settling time experimentally. Study on the effect of proportional, integral, and derivative control actions of a second-order system. Tuning of PID parameters in simulation to improve transient and steady-state performance. Implementation of PID control on a second-order system using an experimental setup. Comparison of experimental results with simulated responses. Design and implementation of PID controllers for DC motor speed control and temperature control or similar systems. Evaluating system performance under load and disturbance conditions. Construction of root locus plots using Computational toolbox for given control systems. Interpretation of system stability and transient response from root locus characteristics. Design of controllers using root locus techniques to meet specified performance requirements. Validation of the designed controller through simulation studies. Integrated analysis of closed-loop systems using PID and root locus-based designs. Comparison of controller performance based on time-domain specifications. Frequency-domain analysis of LTI systems using Bode plots in technical computing tools. Study on gain margin, phase margin, bandwidth, and their implications on system stability and performance.

Ogata K., Modern Control Engineering, 5th edition, Prentice Hall, 2010
Handbooks: Khalil H.K., Nonlinear Systems, 3rd edition, Prentice Hall, 2002.
M. Gopal, "Control Systems: Principles and Design", 4th edition, Mcgraw Higher Ed, 2012.
SWAYAM: R. Pasumarthy and M. Mukherjee, Control Engineering, NPTEL, IIT Madras & IIEST Shibpur, https://onlinecourses.nptel.ac.in/noc26_ee68/preview
C.S. Shankar Ram Control Systems, NPTEL, SWAYAM, Indian Institute of Technology Madras, https://nptel.ac.in/courses/107106081

EE256N ANALOG ELECTRONICS LAB (0-0-4) 2

Study of laboratory instruments, safety practices, and verification of basic diode characteristics. Zener diode characteristics and design of a simple voltage regulator. Half-wave and full-wave rectifiers with and without filter circuits. Input and output characteristics of BJT in CE configuration. Design and analysis of BJT CE amplifier; measurement of gain and bandwidth. MOSFET characteristics and common-source amplifier performance. Operational amplifier characteristics: offset voltage, bias current, slew rate. Non-linear op-amp applications: comparator, Schmitt trigger, precision rectifier. Frequency response of BJT CE amplifier; cutoff frequency measurement. Linear op-amp applications: inverting, non-inverting, summing amplifier. Linear op-amp application: Integrator, differentiator, voltage follower. Low pass and high pass filters design.

Textbooks: R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, Pearson Education.
A. S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford University Press.
Handbooks: Horowitz and Hill, The Art of Electronics, Cambridge University Press.
S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits, McGraw-Hill.
SWAYAM: Pradip Mandal, Analog Electronic Circuits, NPTEL, IIT Kharagpur, (https://nptel.ac.in/courses/108105158)

EE301N POWER ELECTRONICS (2-1-0) 3

Diode and SCR: PN junction diode structure, static and dynamic characteristics, SCR structure, V–I characteristics, triggering, turn-on and turn-off behavior, and applications. MOSFET and IGBT structures, modes of operation, static and dynamic characteristics, switching behavior, and applications in power electronic circuits. Overview of wide bandgap devices device datasheet interpretation, ideal versus practical switching behavior, and basics of thermal dissipation in power semiconductor devices. Principle of operation of the DC–DC converter, steady-state analysis, voltage and current waveforms, operating modes, and basic

applications. Operating principles of boost and buck-boost DC–DC converters, steady-state analysis in continuous conduction mode, voltage and current waveforms, effect of duty ratio, operating modes, and typical applications. Design and analysis of Ćuk and SEPIC converters, including operating principles, steady-state analysis, voltage and current waveforms, and component selection. ZETA converter: design, analysis, and applications. Design and analysis of isolated DC–DC flyback converter, with emphasis on operating modes, transformer isolation, and applications. Design and analysis of isolated DC–DC converters, including forward, and push–pull converters, with emphasis on operating modes, transformer isolation, and applications. Basic concept of DC–AC conversion, Classification of inverters, Single-phase inverters: half-bridge and full-bridge configurations, Operation with resistive and inductive loads, Output voltage and current waveforms, Three-phase inverter configurations, 120° and 180° conduction modes, Introduction to Pulse Width Modulation (PWM), Sinusoidal PWM: principle and waveform generation, Effect of modulation index on output voltage. Overview of Space Vector PWM, Harmonics in inverter output and performance parameters, Inverter control techniques, Applications of DC–AC converters in motor drives, UPS, renewable energy systems. Uncontrolled rectifiers: types, analysis, and operation of single-phase (1ϕ) and three-phase (3ϕ) rectifiers, Power Factor Correction Converter. Introduction to phase-controlled rectifiers, principle of phase control using thyristors, operation and analysis of single-phase (1ϕ) phase-controlled rectifiers with different loads, effect of firing angle on output voltage and current, performance parameters, and applications of controlled rectifiers. Operation and characteristics of three-phase (3ϕ) phase-controlled rectifiers with different loads, effect of firing angle on output voltage and current, performance parameters, and applications of controlled rectifiers. AC–AC conversion: concepts and applications, AC voltage controllers (single-phase and three-phase), and introduction to cycloconverters, including operating principles and performance characteristics.

Textbooks: D. W. Hart, Power Electronics, New York, NY, USA: McGraw-Hill, 2010.
N. Mohan, T. Undeland, W. Robbins, Power Electronics: Converters Applications and Design, New York: Wiley, 1995.
M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, 2nd ed., Englewood Cliffs, NJ: Prentice Hall.
L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Kluwer Academic Publisher.
Handbooks: P. C. Sen, Modern Power Electronics, S. Chand & Company Ltd., New Delhi, 2nd Edition.
SWAYAM: L. Umanand. Fundamental of Power Electronics, SWAYAM–NPTEL IISc Bangalore, https://onlinecourses.swayam2.ac.in/ntr25_ed137/preview

EE303N POWER SYSTEMS (2-1-0) 3

Introduction. Inductance of single-phase lines, three-phase lines with symmetrical and unsymmetrical spacing, double-circuit lines and bundled conductors. Concept of GMD and GMR. Capacitance of single-phase lines, three-phase lines with symmetrical and unsymmetrical spacings, double-circuit lines and bundled conductors. Effect of earth on capacitance calculation. Skin effect and proximity effect. Modelling of long, medium, and short transmission lines, equivalent circuit representations, ABCD parameters, regulation and efficiency, Ferranti effect. One-line diagram, per unit system representation on single-phase and three-phase systems, changing the base of per unit quantities. Impedance/reactance diagram. Examples on reactance diagram. Y-bus formulation based on inspection method, Introduction to load flow, power balance equation formulation, bus classification. Load flow analysis using Newton-Raphson (NR) method. Short-circuit analysis: Introduction, dynamic behavior of synchronous machine under no-load, sub-transient, transient, and steady-state conditions, effect of dc off-set current on symmetrical short-circuit current, calculation of circuit breaker ratings. Short-circuit current calculation of three-phase symmetrical fault under no-load and loaded conditions, symmetrical fault analysis of sample power systems. Sequence components of voltage/current. Relationship between the phase and sequence components, three-phase power in sequence components, sequence impedance and networks of synchronous machines. Sequence impedance and networks of transmission line with and without coupling case, load, transformer. Zero sequence networks. Analysis of unsymmetrical faults on unloaded generator for single line to ground fault, line to line fault, double line to ground fault. Deriving the

positive, negative and zero sequence networks of sample power systems. Sequence network to simulate different types of faults on power systems for single line to ground fault, line to line fault, double line to ground fault. Introduction to power system stability, Swing equation, Equal area criterion for power system stability analysis.

Textbooks: John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994.
P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.
Handbooks: A. R. Bergen and V. Vittal, "Power Systems Analysis", Prentice-Hall, 2000.
J. D. Glover, T. J. Overbye and M. S. Sarma, "Power System Analysis & Design", Cengage Learning, 2015.
SWAYAM: Prof. Debapriya Das, "Power System Analysis", IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc19_ee62/preview

EE305N ELECTRICAL MACHINES - 2 (2-1-0) 3

DC machines: construction, classification, working principle, EMF and torque equation. DC machines: circuit model, armature reaction, methods of excitation. DC generators: characteristics, self-excitation and efficiency. DC motors: characteristics, starting, speed control and efficiency, DC motors: Testing and performance. Three-phase synchronous generators: construction, working principle, types, EMF equation. Three-phase synchronous generators: handling of harmonics, armature reaction, circuit model. Three-phase synchronous generators: open-circuit and short-circuit characteristics, calculation of voltage regulation, steady-state power angle characteristics. Three-phase synchronous generators: Synchronizing to infinite busbars, operating characteristics, V and inverted-V curves. Three-phase synchronous generators: salient-pole generator, two-reaction model, steady-state power angle characteristics. Three-phase synchronous generators: load sharing, Swing equation. Three-phase synchronous motor: basic principles, steady-state operation, starting, applications. Permanent Magnet Synchronous Motor (PMSM) and BLDC: Constructions, working principles, features, advantages, limitations and applications. Switched Reluctance Motor (SRM): Constructions, working principles, features, advantages, limitations and different applications. Synchronous Reluctance Motor (SynRM), stepper motors.

Textbooks: A. E. Fitzgerald, Charles Kingsley Jr. and Stephen D Umans, Electric Machinery, McGraw Hill, Sixth Edition, 2003.
Stephen. J. Chapman, Electric Machinery Fundamentals, 5th ed. New York, NY, USA: McGraw-Hill Education, 2012.
Handbooks: 1. M.G. Say, "The Performance and Design of Alternating Current Machines", CBS Publishers, 1983.
2. D.P. Kothari and I.J. Nagrath, "Electric Machines," Tata McGraw Hill Education, Fourth Edition, 2010.
SWAYAM: Prof. G. Bhuvaneshwari, "Electrical Machines", IIT Delhi.
https://onlinecourses.nptel.ac.in/noc21_ee24/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – I", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc25_ee124/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – II", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc23_ee55/preview
Dr. A. Venkadesan, "Induction, Synchronous and Special Electrical Machines", NIT Puducherry., https://onlinecourses.swayam2.ac.in/ntr25_ed135/preview

EE302N POWER ELECTRONICS LAB (0-0-4) 2

All experiments will be conducted and verified using practical hardware setups as well as simulation tools. MOSFET: Static characteristics – transfer and output characteristics; identification of operating regions. Investigation of IGBT static characteristics: transfer and output characteristics, and operating regions. Investigation of SCR static characteristics: forward/reverse blocking, forward conduction, latching and holding currents, and gate triggering effects. Performance analysis of uncontrolled rectifier with R and RL load. Performance analysis of full wave-controlled rectifier with R and RL load. Firing circuit for MOSFET/IGBT &

Performance analysis of DC-DC Buck converter with R load. Firing circuit for MOSFET/IGBT & Performance analysis of DC-DC Boost converter with R load. Pulse-Width Modulation (PWM) effects on single phase inverter output. Analysis of AC voltage controller and angle control. Design of Inductor for converters. Design of high frequency transformer. Design of snubbers and heat sink.

Textbooks: D. W. Hart, Power Electronics, New York, NY, USA: McGraw-Hill, 2010.
N. Mohan, T. Undeland, W. Robbins, Power Electronics: Converters Applications and Design, New York: Wiley, 1995.
M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, 2nd ed., Englewood Cliffs, NJ: Prentice Hall.
L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Kluwer Academic Publisher.
Handbooks: Joseph Vithayathil, Power Electronics: Principles and Applications, Tata McGraw-Hill Education, New Delhi, 2nd Edition
P. C. Sen, Modern Power Electronics, S. Chand & Company Ltd., New Delhi, 2nd Edition
SWAYAM: L. Umanand, Fundamental of Power Electronics, SWAYAM–NPTEL IISc Bangalore, https://onlinecourses.swayam2.ac.in/ntr25_ed137/preview

EE304N POWER SYSTEMS LAB (0-0-4) 2

Tutorial on Simulation software. String efficiency and voltage distribution of insulators. Voltage regulation and efficiency characteristics of transmission lines. Ferranti effect of medium and long transmission lines, and ABCD parameters of the transmission network. Formation of bus admittance matrix for large power systems. Load flow analysis using Gauss-Siedel method. Load flow analysis using NR method. Load flow analysis using decoupled and fast decoupled methods. Symmetrical fault analysis of a power system. Unsymmetrical fault analysis of a power system. Study of numerical integration methods and its application to electrical circuit transients. Stability analysis of power systems using numerical integration methods.

Textbooks: John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994.
P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.
Handbooks: A. R. Bergen and V. Vittal, "Power Systems Analysis", Prentice-Hall, 2000.
J. D. Glover, T. J. Overbye and M. S. Sarma, "Power System Analysis & Design", Cengage Learning, 2015.
SWAYAM: Prof. Debapriya Das, "Power System Analysis", IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc19_ee62/preview

EE306N ELECTRICAL MACHINES - 2 LAB (0-0-4) 2

Introduction to DC machines and synchronous machines Lab. Open-circuit characteristics of a DC generator. Load test on a DC shunt generator. Speed control of a DC motor. No-load test on a DC motor and predetermination of efficiency. Load test on a dc shunt motor and performance analysis. Open-circuit test, short-circuit test and load test on a synchronous generator, and estimation of voltage regulation by EMF method. Study of Synchronous Motor Characteristics. Synchronization of an alternator to three-phase mains. Load test on a BLDC motor. Load test on SRM. Load test on PMSM.

Textbooks: A. E. Fitzgerald, Charles Kingsley Jr. and Stephen D Umans, Electric Machinery, McGraw Hill, Sixth Edition, 2003.
Stephen. J. Chapman, Electric Machinery Fundamentals, 5th ed. New York, NY, USA: McGraw-Hill Education, 2012.
Handbooks: M.G. Say, "The Performance and Design of Alternating Current Machines", CBS Publishers, 1983.
D.P. Kothari and I.J. Nagrath, "Electric Machines," Tata McGraw Hill Education, Fourth Edition, 2010.
SWAYAM: Prof. G.Bhuvaneshwari, "Electrical Machines", IIT Delhi.
https://onlinecourses.nptel.ac.in/noc21_ee24/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – I", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc25_ee124/preview

Prof. Tapas Kumar Bhattacharya, "Electrical Machines – II", IIT Kharagpur., https://onlinecourses.nptel.ac.in/noc23_ee55/preview
Dr. A. Venkadesan, "Induction, Synchronous and Special Electrical Machines", NIT Puducherry., https://onlinecourses.swayam2.ac.in/ntr25_ed135/preview

EE351N C PROGRAMMING FOR ELECTRICAL ENGINEERS (2-0-2) 3

Introduction to problem solving through programs, algorithms, flowcharts and pseudocode, structure of a C program, the compilation and linking process, editors, compilers and debuggers. Character set, identifiers, keywords, constants and variables, fundamental data types, type qualifiers and type conversion, storage classes, input and output using formatted I/O functions. Operators and expressions: arithmetic, relational, logical, assignment, increment and decrement, conditional and bitwise operators, operator precedence and associativity. Conditional branching using if, if-else, nested if-else and switch-case constructs; iterative constructs using while, do-while and for loops; nested loops, break and continue. Arrays: one-dimensional and two-dimensional arrays, declaration, initialisation and traversal, searching and sorting algorithms, matrix operations. Strings: representation, standard string handling functions, character-oriented processing. Functions: declaration, definition and call, parameter passing by value, scope and lifetime of variables, recursion, modular program design, standard library functions including the mathematical library. Pointers: address arithmetic, pointers and arrays, pointers to functions, dynamic memory allocation using malloc, calloc, realloc and free. Structures and unions, arrays of structures, structures and pointers, self-referential structures, introduction to linked lists. File handling: text and binary files, opening, reading, writing, appending and closing files, command-line arguments. Preprocessor directives, macros and conditional compilation. Numerical and engineering applications in C: solution of algebraic and transcendental equations, matrix inversion and solution of linear systems, numerical integration and differentiation, curve fitting, transient response computation of R-L and R-C circuits, load-flow style iterative computations, and data logging and post-processing of measured electrical quantities. Good programming practice: code readability, documentation, testing and debugging strategies. Laboratory exercises to supplement the course.

Textbooks: B. W. Kernighan and D. M. Ritchie, The C Programming Language, 2nd ed. Englewood Cliffs, NJ, USA: Prentice Hall, 1988.
E. Balagurusamy, Programming in ANSI C, 8th ed. New Delhi, India: McGraw Hill Education, 2019.
Y. Kanetkar, Let Us C, 18th ed. New Delhi, India: BPB Publications, 2021.
P. Dey and M. Ghosh, Computer Fundamentals and Programming in C, 2nd ed. New Delhi, India: Oxford University Press, 2013.
S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, 7th ed. New York, NY, USA: McGraw-Hill, 2015.
Handbooks: S. P. Harbison and G. L. Steele Jr., C: A Reference Manual, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall.
P. J. Plauger, The Standard C Library, Prentice Hall.
SWAYAM: Problem Solving through Programming in C, Prof. Anupam Basu, IIT Kharagpur, https://nptel.ac.in/courses/106105171
Introduction to Programming in C, NPTEL, https://onlinecourses.nptel.ac.in/noc23_cs02/preview

EE352N RENEWABLE ENERGY SYSTEMS (3-0-0) 3

Global and national energy scenarios; environmental impacts of conventional energy sources; classification and potential of renewable energy sources; importance and challenges of integrating renewable energy into existing power systems; policy and national outlook. Sun-earth relationships, radiation spectrum, extra-terrestrial and terrestrial radiation, spectral power distribution, measurement of solar radiation. Solar collectors; solar water heating; passive space heating and cooling; solar industrial process heating; solar refrigeration and air conditioning; solar cookers, furnace, greenhouse, dryers and distillation; solar thermo-mechanical systems. Photovoltaic effect; solar cell fundamentals, characteristics and classification; solar cell technologies; modelling of solar cells and V-I characteristics; module and array construction. Maximum power point tracking

techniques. Batteries and their application in solar PV systems. PV power electronics: design of standalone and grid-tied PV systems; solar PV applications and case study. Origin and nature of wind; wind resource assessment; major applications of wind power; wind turbine types and construction. Forces on a wind turbine, aerodynamic efficiency, tip speed ratio, pitch angle and pitch control; modelling and characteristics of wind turbines. Wind Energy Conversion Systems (WECS): power electronics, induction machines, DFIG and BLDC generators; control of wind turbine systems; wind energy storage. Usable forms of biomass, biomass resources, biomass conversion technologies, biomass gasification, biomass production from waste. Ocean energy: tidal energy, ocean wave energy and ocean thermal energy conversion (OTEC). Introduction to geothermal energy. Layout of a micro-hydro scheme; water turbines, turbine classification, characteristics and selection; generators; site considerations for small and micro hydro. Green hydrogen technology: concept, classification and production of hydrogen; hydrogen storage, transport, applications and safety issues. Fuel cells: working principles and electrochemical reactions, classification of fuel cells, performance characteristics and efficiency, fuel cell systems, control and applications.

Textbooks: C. S. Solanki, Renewable Energy Technologies: A Practical Guide for Beginners, New Delhi, India: Prentice-Hall of India, 2008.
B. H. Khan, Non-Conventional Energy Resources, 3rd ed., New Delhi, India: McGraw-Hill Education, 2017.
G. D. Rai, Non-Conventional Energy Sources, New Delhi, India: Khanna Publishers, 2011.
J. Twidell and T. Weir, Renewable Energy Resources, 4th ed., London, U.K.: Routledge, 2021.
P. S. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 3rd ed., New Delhi, India: Tata McGraw-Hill, 2008.
C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, 3rd ed., New Delhi, India: PHI Learning, 2015.
J. F. Manwell, J. G. McGowan, and A. L. Rogers, Wind Energy Explained: Theory, Design and Application, 2nd ed., Chichester, U.K.: Wiley, 2009.
R. Teodorescu, M. Liserre, and P. Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, Hoboken, NJ, USA: Wiley-IEEE Press, 2011.
J. Larminie and A. Dicks, Fuel Cell Systems Explained, 3rd ed., Chichester, U.K.: Wiley, 2012.
Handbooks: A. F. Zobaa and R. C. Bansal, Eds., Handbook of Renewable Energy Technology, World Scientific.
T. Burton, N. Jenkins, D. Sharpe, and E. Bossanyi, Wind Energy Handbook, Wiley.
SWAYAM: Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems, IIT Guwahati, https://onlinecourses.nptel.ac.in/noc25_ch40/preview
Renewable Energy Engineering, NPTEL, https://nptel.ac.in/courses/103103206

EE353N EMBEDDED SYSTEM DESIGN (2-0-2) 3

Introduction to embedded systems: characteristics, design metrics and design challenges, classification of embedded systems, application domains, embedded system design flow and hardware-software co-design. Embedded processor architectures: microprocessor versus microcontroller, Harvard and von Neumann organisation, RISC and CISC, general purpose processors, application specific instruction set processors, DSP cores and system-on-chip. Architecture and programming of a representative microcontroller: register organisation, memory map, addressing modes, instruction set, assembly and embedded C programming, cross-compilation toolchain, linker scripts, start-up code and debugging with in-circuit emulators. On-chip peripherals and interfacing: general purpose I/O, timers and counters, capture and compare units, watchdog timer, pulse width modulation, analog-to-digital and digital-to-analog converters, real-time clock, interrupt structure, interrupt latency and priority, polling versus interrupt driven design, direct memory access. Interfacing of switches, keypads, LEDs, seven-segment and LCD displays, relays, sensors and actuators; motor drive interfacing for DC, stepper and BLDC motors. Serial communication and embedded protocols: UART, SPI, I2C, CAN and USB; wireless interfaces and their use in embedded products. Power management and low-power design: operating modes, clock gating and energy-aware programming. Real-time systems: hard and soft real-time constraints, task models, scheduling policies including rate monotonic and earliest

deadline first, inter-task communication, semaphores and mailboxes, introduction to real-time operating systems and their use on microcontrollers. Reliability, testing, verification and safety considerations in embedded product design; introduction to ARM Cortex-M architecture and to embedded systems for the Internet of Things. Laboratory exercises to supplement the course.

Textbooks: R. Kamal, Embedded Systems: Architecture, Programming and Design, 3rd ed. New Delhi, India: McGraw Hill Education, 2017.
F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction. Hoboken, NJ, USA: Wiley, 2002.
J. Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, 3rd ed. Oxford, U.K.: Newnes, 2013.
M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2007.
K. V. Shibu, Introduction to Embedded Systems, 2nd ed. New Delhi, India: McGraw Hill Education, 2016.
Handbooks: R. Zurawski, Ed., Embedded Systems Handbook, 2nd ed., CRC Press.
J. Ganssle, Ed., Embedded Systems: World Class Designs, Newnes.
SWAYAM: Introduction to Embedded System Design, NPTEL, https://onlinecourses.nptel.ac.in/noc26_cs22/preview
Embedded System Design with ARM, IIT Kharagpur, https://nptel.ac.in/courses/106105193

EE354N ELECTROMAGNETIC THEORY (3-0-0) 3

Review of vector algebra and vector calculus: coordinate systems, gradient, divergence and curl, divergence and Stokes' theorems, Laplacian operator. Electrostatics: Coulomb's law, electric field intensity due to discrete and continuous charge distributions, electric flux density, Gauss's law and its applications, electric potential, potential gradient, energy density in electrostatic fields. Conductors, dielectrics and capacitance: current and current density, continuity equation, conduction and convection, polarisation, boundary conditions at material interfaces, capacitance of standard geometries, method of images. Poisson's and Laplace's equations, uniqueness theorem, analytical and numerical solution of boundary value problems. Magnetostatics: Biot-Savart law, Ampere's circuital law, magnetic flux density, magnetic scalar and vector potentials, magnetic forces, torque and moment, magnetic materials and boundary conditions, magnetic circuits, self and mutual inductance, magnetic energy, forces on magnetic materials. Time-varying fields: Faraday's law of electromagnetic induction, motional and transformer EMF, displacement current, Maxwell's equations in differential and integral form for time-varying fields, time-harmonic fields and phasor representation, boundary conditions. Electromagnetic wave propagation: wave equation, uniform plane waves in free space, lossless dielectrics, lossy dielectrics and good conductors, skin effect and skin depth, polarisation of waves, Poynting vector and power flow, reflection and refraction of plane waves at normal and oblique incidence, standing waves. Introduction to transmission lines: distributed parameter model, transmission line equations, characteristic impedance, propagation constant, reflection coefficient, standing wave ratio, impedance matching and the Smith chart. Applications of field theory in electrical engineering: electric field grading and insulation design, eddy currents, proximity effect, electromagnetic interference and compatibility, and field computation in electrical machines and apparatus.

Textbooks: M. N. O. Sadiku, Elements of Electromagnetics, 7th ed. New York, NY, USA: Oxford University Press, 2018.
W. H. Hayt Jr. and J. A. Buck, Engineering Electromagnetics, 8th ed. New York, NY, USA: McGraw-Hill, 2012.
D. K. Cheng, Field and Wave Electromagnetics, 2nd ed. Reading, MA, USA: Addison-Wesley, 1989.
J. D. Kraus and D. A. Fleisch, Electromagnetics with Applications, 5th ed. New York, NY, USA: McGraw-Hill, 1999.
E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, 2nd ed. New Delhi, India: PHI Learning, 2015.
Handbooks: R. C. Dorf, Ed., The Electrical Engineering Handbook, CRC Press.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.

SWAYAM: Electromagnetic Theory, IIT Kanpur, https://onlinecourses.nptel.ac.in/noc21_ee83/preview
Electromagnetic Fields, NPTEL, https://nptel.ac.in/courses/108106073

EE355N FUNDAMENTALS OF ELECTRIC VEHICLES (3-0-0) 3

Evolution of electric vehicles from early electric cars to modern battery electric vehicles; classification of electric vehicles into BEV, HEV, PHEV and FCEV; comparison with internal combustion engine vehicles in terms of energy efficiency and emissions; the electric vehicle ecosystem and the national and global outlook. Vehicle dynamics: forces acting on vehicles including rolling resistance, gradient and aerodynamic forces; concept of tractive force and power requirement; acceleration and gradeability; energy consumption estimation using standard drive cycles. Electric propulsion architectures: series, parallel and series-parallel powertrain configurations; comparative analysis of layouts through case studies; overview of components comprising motor, battery, controller and charger; sizing basics covering power rating and the torque-speed envelope. Electric motors for electric vehicles: characteristics of BLDC, PMSM, induction and switched reluctance motors; torque-speed characteristics and suitability for traction; motor selection for typical vehicle categories; drive system block diagram and the role of the inverter. Battery systems: battery chemistries including Li-ion, LFP and NMC; battery ratings covering voltage, capacity and C-rate; introduction to battery pack design and thermal considerations; equivalent circuit representation using the Thevenin model. Fundamentals of battery management: role and functions of a battery management system; voltage, current and temperature monitoring; basic state-of-charge estimation methods; safety features including overvoltage and overcurrent protection. Electric vehicle charging systems: modes of charging covering Level 1, Level 2 and DC fast charging; technical and infrastructure aspects of AC versus DC charging; charging connectors and standards including GB/T, CCS and CHAdeMO; introduction to inductive charging. Case studies and emerging trends: electric bus technologies and deployment experience; Indian electric vehicle policy, the FAME scheme and the charging infrastructure plan; emerging trends including vehicle-to-grid operation, solar charging and battery swapping; career pathways in electric vehicle technology.

Textbooks: G. A. Goodarzi and J. G. Hayes, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, Wiley, 2017.
C. C. Chan and K. T. Chau, Modern Electric Vehicle Technology, New York, NY, USA: Oxford University Press, 2001.
M. Ehsani, Y. Gao, S. E. Gay, and A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
H. Abu-Rub, M. Malinowski, and K. Al-Haddad, Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications, Wiley, 2014.
S. J. Chapman, Electric Machinery Fundamentals, 4th ed. New York, NY, USA: McGraw-Hill, 2003.
Handbooks: A. Emadi, Ed., Handbook of Automotive Power Electronics and Motor Drives, CRC Press.
D. Linden and T. B. Reddy, Eds., Linden's Handbook of Batteries, McGraw-Hill.
SWAYAM: Fundamentals of Electric Vehicles: Technology and Economics, Prof. Ashok Jhunjhunwala, IIT Madras, https://onlinecourses.nptel.ac.in/noc20_ee99/preview
Electric Vehicles - Part 1, IIT Delhi, https://onlinecourses.nptel.ac.in/noc22_ee53/preview

EE356N DIGITAL SYSTEMS DESIGN (2-0-2) 3

Synchronous sequential finite state machines: flip-flops, counters and shift registers; state diagrams, state tables and design procedure; implementation using gates and flip-flops; design considerations including propagation delay, clock skew, speed and handshaking; implementation of synchronous finite state machines. Introduction to Verilog: overview of hardware description languages; Verilog syntax covering data types, operators and modules; modelling styles comprising structural, dataflow and behavioural descriptions; simulation and synthesis of basic combinational and sequential circuits in Verilog. Finite state machine based controller design using Verilog: Mealy and Moore machine modelling in Verilog; sequence detectors and code converters; state encoding; controller design examples. Introduction to programmable logic devices and exposure to SSI and MSI logic integrated circuits used as digital system building blocks: brief overview of

programmable logic devices, simple programmable logic devices (SPLDs), complex programmable logic devices (CPLDs) and field-programmable gate arrays (FPGAs); review of combinational logic design using PLDs. Analysis and design of asynchronous sequential finite state machines: fundamentals and design techniques, hazards, races, synchronization techniques and implementation using latches and gates. Laboratory exercises to supplement the course.

Textbooks: M. M. Mano and M. D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, Pearson Prentice Hall, 2013.
J. F. Wakerly, Digital Design: Principles and Practices, 3rd ed. Prentice Hall, 2001.
W. I. Fletcher, An Engineering Approach to Digital Design, New Delhi, India: PHI Learning.
M. J. S. Smith, Application Specific Integrated Circuits, Addison Wesley, 1999.
C. H. Roth, Digital Systems Design Using VHDL, PWS Publishing, 1997.
Handbooks: W.-K. Chen, Ed., The VLSI Handbook, 2nd ed., CRC Press.
D. D. Givone, Digital Principles and Design, McGraw-Hill.
SWAYAM: Digital System Design, Prof. Neeraj Goel, IIT Ropar, https://onlinecourses.nptel.ac.in/noc25_ee24/preview
Hardware Modelling using Verilog, Prof. Indranil Sengupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc20_cs63/preview

EE357N DIGITAL COMPUTER ORGANISATION AND ARCHITECTURE (3-0-0) 3

Evolution of computers: generations of computing machines, von Neumann and Harvard architectures, functional units of a digital computer, performance measures and benchmarking, Amdahl's law, instruction set architecture, RISC and CISC design philosophies, machine instructions, instruction formats and addressing modes, assembly language programming and subroutine linkage. Processor design and functional units: arithmetic and logic unit organisation, fixed-point addition, subtraction, multiplication using Booth's algorithm and restoring and non-restoring division, floating-point representation and IEEE 754 standard, floating-point arithmetic units, register organisation and datapath design, single-cycle and multi-cycle datapaths. Computer architectures and control unit design: hardwired control and microprogrammed control, horizontal and vertical microinstructions, control sequencing, instruction pipelining, pipeline hazards comprising structural, data and control hazards and their resolution through forwarding, stalling and branch prediction, introduction to superscalar and multicore architectures, parallel processing and Flynn's classification. Memory and input-output organisation: memory hierarchy, semiconductor memories, memory interleaving, cache memory principles, mapping functions, replacement algorithms and write policies, cache performance, virtual memory, paging, segmentation and translation lookaside buffers, secondary storage. Input-output organisation: programmed I/O, interrupt driven I/O, interrupt structure and priority, direct memory access, I/O interfaces, buses, bus arbitration and standard I/O interfaces. Introduction to system software and operating systems: assemblers, loaders and linkers, functions of an operating system, process and memory management, and the interaction between hardware organisation and system software.

Textbooks: J. P. Hayes, Computer Architecture and Organisation, 2nd ed. New York, NY, USA: McGraw-Hill, 1988.
M. Rafiquzzaman and R. Chandra, Modern Computer Architecture, New Delhi, India: Galgotia, 1999.
C. Hamacher, Z. Vranesic, and S. Zaky, Computer Organization, 5th ed. New York, NY, USA: McGraw-Hill, 2002.
D. A. Patterson and J. L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 5th ed. Waltham, MA, USA: Morgan Kaufmann, 2013.
W. Stallings, Computer Organization and Architecture: Designing for Performance, 10th ed. Upper Saddle River, NJ, USA: Pearson, 2016.
Handbooks: V. G. Oklobdzija, Ed., The Computer Engineering Handbook, CRC Press.
R. C. Dorf, Ed., The Electrical Engineering Handbook, CRC Press.
SWAYAM: Computer Architecture and Organization, Prof. Indranil Sengupta and Prof. Kamalika Datta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc22_cs88/preview

Computer Architecture, Prof. Smruti R. Sarangi, IIT Delhi, https://nptel.ac.in/courses/106102157

EE358N COMPUTER NETWORKS (3-0-0) 3

Introduction to computer networks and the physical layer: uses of computer networks, network hardware and software, network topologies, local area, metropolitan area and wide area networks, layered architectures, the OSI reference model and the TCP/IP protocol suite, network standardisation. Physical layer: theoretical basis for data communication, Fourier analysis of signals, bandwidth-limited signals, maximum data rate of a channel, guided transmission media comprising twisted pair, coaxial cable and optical fibre, wireless transmission, digital modulation and multiplexing, frequency division, time division and code division multiplexing, switching techniques. Data link layer and media access control: design issues, framing, error detection and correction codes including parity, checksum, cyclic redundancy check and Hamming codes, elementary data link protocols, sliding window protocols, stop-and-wait ARQ, go-back-N and selective repeat ARQ, flow control. Medium access control sublayer: channel allocation problem, multiple access protocols including ALOHA, CSMA, CSMA/CD and CSMA/CA, collision-free protocols, Ethernet and its variants, wireless LANs and IEEE 802.11, data link layer switching, bridges, switches and virtual LANs. Network layer: design issues, routing algorithms comprising shortest path, flooding, distance vector and link state routing, hierarchical routing, broadcast and multicast routing, congestion control algorithms, quality of service, internetworking, the Internet Protocol, IPv4 and IPv6 addressing, subnetting and classless addressing, network address translation, ICMP, ARP, DHCP, and the interior and exterior gateway protocols OSPF and BGP. Transport layer: transport service primitives, elements of transport protocols, addressing, connection establishment and release, error control and flow control, multiplexing, UDP and TCP, TCP segment structure, connection management, TCP transmission policy, congestion control, timer management and performance issues. ATM and network applications: ATM architecture, reference model, ATM adaptation layers and services; application layer protocols including DNS, electronic mail, FTP, HTTP and the World Wide Web, streaming audio and video, content delivery networks, and an introduction to network security.

Textbooks: A. S. Tanenbaum and D. J. Wetherall, Computer Networks, 5th ed. Upper Saddle River, NJ, USA: Pearson Education, 2011.
J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach, 7th ed. Boston, MA, USA: Pearson, 2017.
B. A. Forouzan, Data Communications and Networking, 5th ed. New York, NY, USA: McGraw-Hill, 2013.
W. Stallings, Data and Computer Communications, 10th ed. Upper Saddle River, NJ, USA: Pearson, 2013.
L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 5th ed. Burlington, MA, USA: Morgan Kaufmann, 2011.
Handbooks: H. Bidgoli, Ed., The Handbook of Computer Networks, Wiley.
R. C. Dorf, Ed., The Electrical Engineering Handbook, CRC Press.
SWAYAM: Computer Networks and Internet Protocol, Prof. Soumya Kanti Ghosh and Prof. Sandip Chakraborty, IIT Kharagpur, https://nptel.ac.in/courses/106105183
Computer Networks, Prof. Ajit Pal, IIT Kharagpur, https://nptel.ac.in/courses/106105081

EE359N SENSORS AND ACTUATORS (2-0-2) 3

Overview and classification of sensors including definitions of sensors, transducers and actuators; classification based on signal type, measurand and application; active versus passive sensors. Operating principles involving variable resistance (strain gauges, thermistors, potentiometers), inductance and reluctance (LVDT, variable reluctance sensors), capacitance (displacement, pressure and proximity sensors), and Hall effect sensors. Force, torque and tactile pressure measurement using contact closure, magnetic, piezoelectric, photoelectric, capacitive and ultrasonic methods, and digital displacement sensors. Pressure measurement using manometers, elastic elements such as the Bourdon tube, bellows and diaphragm, and electrical and piezoelectric transducers. Flow measurement principles covering laminar and turbulent flow characteristics and Bernoulli's principle relating pressure and velocity; flow sensors and transducers including differential pressure flowmeters (Pitot tube, orifice plate, Venturi tube), variable area flowmeters (rotameter) and

mechanical flow sensors of turbine, paddlewheel and positive displacement types; electromagnetic flowmeters, ultrasonic flowmeters using Doppler shift and transit time methods, thermal anemometers, vortex shedding flowmeters and industrial-grade flow sensors. Smart sensor technology including on-chip signal conditioning, temperature and linearity compensation and signal digitisation; communication interfaces such as I2C, SPI and UART; integrated sensor-microcontroller systems, information coding and data fusion. Applications of sensors in robotics and automation covering potentiometers, synchros, resolvers, incremental and absolute optical encoders, capacitive, resistive and optical tactile sensors, and proximity or non-contact ranging sensors including infrared, ultrasonic and LiDAR. Pneumatic and hydraulic actuators including the operation of control valves, cylinders and rotary actuators with applications in automation systems. Mechanical actuation systems covering types of motion, kinematic chains, linkages and force transmission elements such as gears, cams, belts and chain drives. Electrical actuators including solid-state switching devices (TRIAC, SCR, relays), solenoids, and motors of various types: DC brush and brushless, single-phase and three-phase AC, stepper and servo motors, piezoelectric actuators, ultrasonic motors and microactuators for MEMS and NEMS applications. Laboratory exercises to supplement the course.

Textbooks: C. W. de Silva, Sensors and Actuators: Engineering System Instrumentation, CRC Press, 2007.
E. O. Doebelin and D. N. Manik, Measurement Systems: Application and Design, 5th ed. New York, NY, USA: McGraw-Hill, 2004.
D. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement Systems, 4th ed. New York, NY, USA: McGraw-Hill, 2011.
D. V. S. Murty, Transducers and Instrumentation, 2nd ed. New Delhi, India: PHI Learning, 2010.
I. R. Sinclair, Sensors and Transducers, 3rd ed. Oxford, U.K.: Newnes, 2001.
S. Nihtianov and A. Luque, Eds., Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, Woodhead Publishing, 2014.
Handbooks: J. Fraden, Handbook of Modern Sensors: Physics, Designs and Applications, Springer.
J. G. Webster and H. Eren, Eds., Measurement, Instrumentation and Sensors Handbook, CRC Press.
SWAYAM: Sensors and Actuators, Prof. Hardik J. Pandya, IISc Bangalore,
https://nptel.ac.in/courses/108108147
Transducers for Instrumentation, NPTEL, https://onlinecourses.nptel.ac.in/noc23_ee105/preview

EE360N INDUSTRIAL PROCESS AUTOMATION (3-0-0) 3

Concepts of automation and the need for automation in process and manufacturing industries; automation system structure and hierarchy; control technologies covering continuous and discrete control, regulatory control, sequence control and advanced control strategies. Instrumentation systems: measurement of process variables including temperature, pressure, flow and level; signal conditioning, transmitters, final control elements and control valves; smart transmitters and field instrumentation. Human interface: operator stations, mimic diagrams, alarm management and human-machine interface design. Automation strategies for batch and continuous processes; programmable control systems: programmable logic controllers, architecture, input-output modules, programming languages of the IEC 61131-3 standard including ladder logic and function block diagrams, distributed control systems and their architecture. Data acquisition and control hardware and software systems: signal conversion, sampling, data acquisition boards, real-time software, configuration and engineering tools. Data communication and networking in industrial environments: serial standards, industrial buses and fieldbus technologies, HART, Profibus, Modbus, Foundation Fieldbus, industrial Ethernet and wireless networks. SCADA platform: architecture, remote terminal units, communication with field devices, historian and reporting functions, redundancy and reliability. Management of industrial processes: plant-wide automation, manufacturing execution systems, enterprise resource planning integration, optimization and energy management. Cyber security issues in industrial control systems: threats, vulnerabilities, defence-in-depth architecture and relevant standards. Information technology applications in process automation including databases, cloud connectivity, analytics and the industrial Internet of Things.

Textbooks: K. L. S. Sharma, Overview of Industrial Process Automation, 2nd ed. Amsterdam, Netherlands: Elsevier, 2017.

K. S. Manoj, Industrial Automation with SCADA, 1st ed. Chennai, India: Notion Press, 2019.
C. D. Johnson, Process Control Instrumentation Technology, 8th ed. Upper Saddle River, NJ, USA: Pearson, 2013.
T. A. Hughes, Programmable Controllers, 4th ed. Research Triangle Park, NC, USA: ISA, 2004.
S. K. Singh, Industrial Instrumentation and Control, 3rd ed. New Delhi, India: McGraw Hill Education, 2009.
Handbooks: B. G. Liptak, Ed., Instrument Engineers' Handbook, Vol. 2: Process Control and Optimization, CRC Press.
S. Y. Nof, Ed., Springer Handbook of Automation, Springer.
SWAYAM: Industrial Automation and Control, Prof. S. Mukhopadhyay and Prof. S. Sen, IIT Kharagpur, https://nptel.ac.in/courses/108105063
Industrial Automation and Control, Prof. Alok Kanti Deb, IIT Kharagpur, https://nptel.ac.in/courses/108105088

EE361N PROBABILITY AND STOCHASTIC PROCESSES (3-0-0) 3

Probability review: sample space and events, conditional probability, total probability, Bayes' theorem, discrete and continuous random variables, expectation, variance and common distributions. Inference and estimation: sampling and statistics, law of large numbers, central limit theorem, maximum likelihood estimation, confidence intervals, hypothesis testing, significance and p-values. Introduction to stochastic processes: classification of processes, sample paths, stationarity, ergodicity, and applications in system modelling and signal variation over time. Poisson and renewal processes: the Poisson process and its properties, interarrival times, nonhomogeneous Poisson processes, renewal processes and applications in outage modelling and component failures. Discrete-time Markov chains: the Markov property, transition matrix, state classification, long-term behaviour, steady-state probabilities and applications in system reliability and control switching. Continuous-time Markov chains: transition rates, generator matrices, exponential holding times and applications to maintenance scheduling and failure modelling in energy systems. Gaussian processes and noise: definition of a Gaussian process, correlation and covariance, power spectral density and applications in communication and sensor noise modelling.

Textbooks: D. P. Bertsekas and J. N. Tsitsiklis, Introduction to Probability, 2nd ed. Nashua, NH, USA: Athena Scientific, 2008.
H. Stark and J. W. Woods, Probability and Random Processes with Applications to Signal Processing, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2012.
A. Papoulis and S. U. Pillai, Probability, Random Variables and Stochastic Processes, 4th ed. New York, NY, USA: McGraw-Hill, 2002.
S. M. Ross, Introduction to Probability Models, 11th ed. Amsterdam, Netherlands: Academic Press, 2014.
Handbooks: D. Zwillinger and S. Kokoska, CRC Standard Probability and Statistics Tables and Formulae, CRC Press.
M. Abramowitz and I. A. Stegun, Handbook of Mathematical Functions, Dover Publications.
SWAYAM: Introduction to Probability Theory and Stochastic Processes, Prof. S. Dharmaraja, IIT Delhi, https://nptel.ac.in/courses/111102111
Applied Stochastic Processes, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc26_ma04/preview

EE362N MACHINE LEARNING (2-0-2) 3

Introduction to machine learning and its mathematical preliminaries: definitions and motivation, applications in engineering and industry, overview of supervised, unsupervised and reinforcement learning, review of linear algebra covering vectors, matrices and eigenvalues, basic probability and statistics, cost functions and gradient descent optimization. Supervised learning: linear regression and logistic regression, k-nearest neighbours and decision trees, model evaluation metrics including accuracy, precision, recall, F1-score and the confusion matrix, cross-validation and model selection techniques. Unsupervised learning: the k-means clustering algorithm, overview of hierarchical clustering, and dimensionality reduction with principal component analysis. Basics of neural networks: single-layer perceptron and activation functions, the feedforward neural network concept, overview of backpropagation, and demonstration with a simple classification example. Practical

considerations and applications: overfitting and underfitting, basics of hyperparameter tuning, and real-world case studies drawn from engineering and energy systems. Laboratory exercises to supplement the course.

Textbooks: T. M. Mitchell, Machine Learning, New York, NY, USA: McGraw-Hill, 1997.
C. M. Bishop, Pattern Recognition and Machine Learning, New York, NY, USA: Springer, 2006.
I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, Cambridge, MA, USA: MIT Press, 2016.
A. Geron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow, 2nd ed. Sebastopol, CA, USA: O'Reilly, 2019.
T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning, 2nd ed. New York, NY, USA: Springer, 2009.
Handbooks: J. Kacprzyk and W. Pedrycz, Eds., Springer Handbook of Computational Intelligence, Springer.
D. Zwillinger and S. Kokoska, CRC Standard Probability and Statistics Tables and Formulae, CRC Press.
SWAYAM: Introduction to Machine Learning, Prof. Balaraman Ravindran, IIT Madras, https://nptel.ac.in/courses/106106139
Machine Learning for Engineering and Science Applications, IIT Madras, (https://onlinecourses.nptel.ac.in/noc19_cs82/preview)

EE363N ELECTRIC DRIVES (2-1-0) 3

Basic elements, types of electric drives, factors influencing electric drives. Dynamics of electrical drives. Speed-torque conventions and multi-quadrant operations, steady state stability of a drive system. Heating and cooling curves, loading conditions, and classes of duty-selection of power rating for drive motors with regard to thermal overloading and load variation factors. Basic elements, types of electric drives, factors influencing electric drives. Dynamics of electrical drives. Speed-torque conventions and multi-quadrant operations, steady state stability of a drive system. Heating and cooling curves, loading conditions, and classes of duty-selection of power rating for drive motors with regard to thermal overloading and load variation factors. Review of induction machines: steady state performance and equivalent circuit. Dynamic modelling of the Induction machine, space phasor model. Control principle of the induction motor, Review of voltage source inverter, Stator voltage control, slip-energy recovery scheme, Voltage source driven induction motor drive: constant v/f control, constant slip-speed control, Introduction to vector control. Review of induction machines: steady state performance and equivalent circuit. Dynamic modelling of the Induction machine, space phasor model. Control principle of the induction motor, Review of voltage source inverter, Stator voltage control, slip-energy recovery scheme, Voltage source driven induction motor drive: constant v/f control, constant slip-speed control, Introduction to vector control.

Textbooks: R. Krishnan, Electric Motor Drives: Modelling, Analysis, and Control, Prentice Hall, 2001.
G. K. Dubey, Fundamentals of Electrical Drives, 2nd ed., Alpha Science International Ltd., 2001.
B. K. Bose, Modern Power Electronics and AC Drives, Prentice Hall, 2002.
N. Mohan, Electric Machines and Drives: A First Course, Wiley, 2011.
Handbooks: P. C. Krause and T. C. Krause, Introduction to Modern Analysis of Electric Machines and Drives, Wiley-IEEE Press, 2022
SWAYAM: Fundamentals of Electric Drives., IIT Kanpur, (https://nptel.ac.in/courses/108104140)

EE364N COMPUTER-AIDED ANALYSIS OF LARGE POWER SYSTEMS (2-1-0) 3

Graph Theory & Network Matrices — trees, co-trees, cut-sets, and loops, Incidence matrices; primitive network representation; singular transformations, Ybus by inspection; Zbus building algorithm; modifications for network changes, Sparsity & Large Linear Systems — power-network sparsity; sparse storage schemes, Sparse LU factorization; fill-in; Tinney ordering schemes 1–3, Forward/backward substitution; sparse vs. dense solution cost

Load Flow Studies — formulation, bus classification, Gauss-Seidel method, Newton-Raphson (polar/rectangular); Jacobian structure; Q-limit handling, Fast Decoupled Load Flow: assumptions and solution method, DC load flow approximation; comparative evaluation of load flow methods, State Estimation — need,

measurement types, WLS formulation,Bad data detection and identification; network observability analysis,Power System Security — security levels; static assessment; contingency ranking (GSF, LODF),Security-Constrained Analysis — preventive/corrective control; voltage security; SCOPF; EMS/SCADA role

Textbooks: Glenn W. Stagg, Ahmed H. El-Abiad, Computer Methods in Power System Analysis, McGraw-Hill, 1968
George Kusic, Computer-Aided Power Systems Analysis, CRC Press, 2018
Handbooks: A. R. Bergen and V. Vittal, "Power Systems Analysis", Prentice-Hall, 2000.
J. D. Glover, T. J. Overbye and M. S. Sarma, "Power System Analysis & Design", Cengage Learning, 2015.
SWAYAM: Computer Aided Power System Analysis, IIT Roorkee, https://nptel.ac.in/courses/108105153

EE365N ELECTRICAL AND ELECTRONICS MEASURING INSTRUMENTS AND TECHNIQUES (2-1-0) 3

Review of units, standards, dimensional analysis. Measurement basics: accuracy, precision, significant figures, errors (quantification and analysis), calibration. Measuring instruments: Analog and digital, Concept of true rms, DVM, multi-meter DMM, resolution, sensitivity. Oscilloscope: specifications, applications. Measurement of voltage, current, frequency, impedance, harmonics, power, power factor, and energy. Extension of meter ranges: Shunts & multipliers, CTs and PTs. Measurement of R, L, C and applications. Indicating, recording and integrating type of instruments. Measurement of non-electrical quantities (Displacement, Pressure, Temperature, Strain, Acoustic, flow and Photo measurement etc.) and instrumentation. Basics of transducers.

Textbooks: Golding and Widdis, Electrical Measurements and Measuring Instruments, Wheeler Publishing House, New Delhi 1979.
K. Sawhney, A Course in Electrical Measurement and Measuring Instruments, Dhanpat Rai and Sons, New Delhi 2007. M. B. Stout, 'Basic Electrical Measurements', Prentice Hall, 1960
Handbooks: B. S. Sonde, 'Transducers and Display Systems', Published by McGraw-Hill Inc., US, 1978.
SWAYAM: Electrical Measurement and Electronic Instruments, IIT Kharagpur, https://nptel.ac.in/courses/108105153

EE401N HIGH VOLTAGE ENGINEERING (3-0-0) 3

Introduction to the basics of high voltage engineering and the need for high voltage in the laboratory: growth of transmission voltages, applications of high direct, alternating and impulse voltages in industry and research, and the role of high voltage laboratories in equipment development and certification. Basics of insulation engineering and the material characterizing features: classification of insulating materials into gaseous, liquid and solid dielectrics; conduction and breakdown in gases including Townsend and streamer mechanisms, Paschen's law, corona discharge and breakdown in non-uniform fields; breakdown in liquid dielectrics and in solid dielectrics covering intrinsic, electromechanical, thermal and treeing mechanisms; composite dielectrics; dielectric constant, loss tangent, partial discharges and ageing; electric field estimation and field grading in practical insulation systems. Generation of high voltages in the laboratory for testing purposes: generation of high direct voltage using rectifiers, voltage doublers and the Cockcroft-Walton multiplier and electrostatic generators; generation of high alternating voltage using cascaded transformers and resonant test systems; generation of impulse voltages and impulse currents, standard lightning and switching impulse waveshapes, single-stage and multistage Marx generators, waveshape control and tripping and control of impulse generators. Measurement methods for high direct, high alternating and high impulse voltages: sphere gaps, electrostatic voltmeters, potential dividers of the resistive, capacitive and damped capacitive types, peak voltmeters, capacitance voltage transformers, the Chubb-Fortescue method, and measurement of high currents; digital techniques in high voltage measurement. High voltage testing techniques used in testing power system components and certification: testing of insulators, bushings, cables, circuit breakers, power transformers and surge arresters; power frequency, impulse and DC test procedures; partial discharge

measurement, dielectric loss and tan-delta measurement, radio interference voltage measurement; non-destructive testing and insulation coordination. Numerical problems substantiating the above theory, simulation assignments as self-study topics, demonstrations in the high voltage laboratory and discussions based on relevant national and international standards.

Textbooks: M. S. Naidu and V. Kamaraju, High Voltage Engineering, 6th ed. New Delhi, India: McGraw Hill Education, 2020.
E. Kuffel, W. S. Zaengl, and J. Kuffel, High Voltage Engineering: Fundamentals, 2nd ed. Oxford, U.K.: Newnes, 2000.
C. L. Wadhwa, High Voltage Engineering, 3rd ed. New Delhi, India: New Age International, 2010.
IS 2071 and other relevant IS, IEEE and IEC standards on high voltage test techniques.
Handbooks: D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
H. M. Ryan, Ed., High Voltage Engineering and Testing, IET.
SWAYAM: High Voltage Engineering, IIT Kanpur, https://nptel.ac.in/courses/108104048
Advances in UHV Transmission and Distribution, NPTEL, https://onlinecourses.nptel.ac.in/noc20_ee67/preview

EE402N PRINCIPLES OF SWITCHGEAR AND PROTECTION (2-0-2) 3

Introduction to switchgear and protection: need for protection, evolution of protective systems, qualities of protection comprising selectivity, sensitivity, speed and reliability, primary and back-up protection, zones of protection, current and voltage transformers for protection and their performance; fuses, their characteristics and application; earthing and neutral grounding practices. Circuit breakers: arc phenomena and arc interruption theories, restriking voltage and rate of rise of restriking voltage, current chopping, interruption of capacitive currents, resistance switching, types of circuit breakers including air-break, air-blast, oil, SF6 and vacuum circuit breakers, specifications and ratings, testing of circuit breakers, auto-reclosing schemes, and other switching devices such as disconnectors and earthing switches. Protective relays: functions, definitions and terminology, fundamental operating characteristics, classification of relays, electromagnetic and induction relays, overcurrent relays and their time-current characteristics, directional overcurrent relays, differential protection schemes, percentage biased differential protection, and distance protection relays and schemes including impedance, reactance and mho characteristics with stepped distance protection. Protection of power apparatus: transformer protection including differential protection, magnetising inrush restraint and Buchholz relay; alternator protection covering stator and rotor faults, loss of excitation and reverse power; transmission line protection using overcurrent, distance and pilot relaying; motor protection; and busbar and frame leakage protection. Solid state relays, duality theorem, phase and amplitude comparison; introduction to static relays, numerical relays and their architecture, digital filtering and phasor estimation, and computer aided protection with communication assisted schemes. Laboratory exercises to supplement the course.

Textbooks: S. S. Rao, Switchgear Protection and Power Systems: Theory, Practice and Solved Problems, New Delhi, India: Khanna Publishers.
Y. G. Paithankar and S. R. Bhide, Fundamentals of Power System Protection, 2nd ed. New Delhi, India: PHI Learning.
B. Ravindranath and M. Chander, Power System Protection and Switchgear, New Delhi, India: New Age International.
J. L. Blackburn and T. J. Domin, Protective Relaying: Principles and Applications, 4th ed. Boca Raton, FL, USA: CRC Press, 2014.
Relevant IS standards and user manuals of switchgear and protection equipment from leading manufacturers.
Handbooks: Network Protection and Automation Guide, Alstom Grid.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
SWAYAM: Power System Protection and Switchgear, Prof. Bhaveshkumar R. Bhalja, IIT Roorkee, https://nptel.ac.in/courses/108107167
Power System Protection, NPTEL, https://nptel.ac.in/courses/108105167

EE403N POWER GENERATION AND ECONOMICS (3-0-0) 3

Steam power plant: introduction, modern steam power plant layout, steam power plant equipment, coal handling, fuel burning furnaces and methods of fuel burning, pulverised coal, pulverised coal firing and burners, ash disposal, smoke and dust removal, draught, chimney, economiser, air preheater, superheater and superheat control, feed water treatment and methods of feed water treatment, steam condenser and types of steam condensers, condenser cooling water supply, steam turbines, steam turbine performance, steam turbine generators, boilers and types of boilers, site selection and cost of a steam power plant. Nuclear power plant: nuclear energy, site selection, chain reaction, parts of a nuclear reactor, classification of reactors, main components of a nuclear power plant, boiling water reactor, pressurised water reactor, sodium graphite reactor, fast breeder reactor, waste disposal, heat exchanger, gas cooled reactor, cost of a nuclear power plant and advantages of nuclear power. Hydro-electric power plant: general layout, site selection, elements of a hydro-electric power plant, selection of site for a dam, classification of hydro-electric power plants, advantages of hydro power, draft tube, surge tank, hydraulic turbines, their classification and choice, spillways and gates in dams, hydrology, hydrograph and mass curve, the hydrologic cycle, underground power plants and safety measures in power plants. Power plant economics: connected load, maximum demand, demand factor, load curve, base load and peak load power plants, load factor, diversity factor, plant capacity factor, plant use factor, load duration curve, types of load, cost of electrical energy, depreciation and types of depreciation, energy rates and tariffs, requirements of a tariff and types of tariff, effect of variable load on power plant operation and design, and numerical problems. Power factor improvement: causes and effects of low power factor, equipment used for power factor improvement, economics of power factor improvement and numerical problems.

Textbooks: P. K. Nag, Power Plant Engineering, 4th ed. New Delhi, India: McGraw Hill Education, 2014.
M. V. Deshpande, Elements of Power Station Design, New Delhi, India: PHI Learning.
G. P. Chalotra, Electrical Engineering Economics, New Delhi, India: Khanna Publishers.
A. Domkundwar and S. C. Arora, A Course in Power Plant Engineering, New Delhi, India: Dhanpat Rai and Co.
S. Rao and B. B. Parulekar, Energy Technology: Non-Conventional, Renewable and Conventional, 4th ed. New Delhi, India: Khanna Publishers.
Handbooks: T. C. Elliott, K. Chen, and R. C. Swanekamp, Standard Handbook of Powerplant Engineering, McGraw-Hill.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
SWAYAM: Power Plant Engineering, Dr. Ravi Kumar, IIT Roorkee,
https://onlinecourses.nptel.ac.in/noc20_me10/preview
Sustainable Power Generation Systems, NPTEL, https://onlinecourses.nptel.ac.in/noc23_ge47/preview

EE404N POWER QUALITY (3-0-0) 3

Power quality fundamentals: overview of power quality issues, key power quality terms and definitions, causes and effects of power quality problems, and relevant power quality standards. Power supply reliability and evaluation: failures, outages and interruptions, their causes and impact on power system reliability, reliability evaluation for power quality, methods and customer-centric indices, customer-based reliability indices, voltage sags and their identification, causes and assessment, and voltage sag mitigation techniques and control approaches. Harmonics in power systems: IEEE guidelines for voltage and current harmonics, identification of harmonic sources including transformers, motors, arc furnaces and power electronic converters, comparison of current and voltage harmonics, effects of harmonics on power systems including power factor degradation, overheating and equipment performance, and mitigation methods with an introduction to passive and active filters for harmonics. Advanced power quality management: monitoring of power quality, the role of grounding, power quality challenges associated with renewable energy sources, and the importance of energy auditing and distribution automation.

Textbooks: C. Sankaran, Power Quality, Boca Raton, FL, USA: CRC Press, 2002.

J. Arrillaga and N. R. Watson, Power System Harmonics, 2nd ed. Chichester, U.K.: Wiley, 2003.
G. T. Heydt, Electric Power Quality, Stars in a Circle Publications, 1991.
R. C. Dugan, M. F. McGranaghan, S. Santoso, and H. W. Beaty, Electrical Power Systems Quality, 3rd ed. New York, NY, USA: McGraw-Hill, 2012.
A. Ghosh and G. Ledwich, Power Quality Enhancement Using Custom Power Devices, Boston, MA, USA: Kluwer Academic, 2002.
M. H. J. Bollen, Understanding Power Quality Problems: Voltage Sags and Interruptions, Piscataway, NJ, USA: IEEE Press, 2000.
Handbooks: A. Baggini, Ed., Handbook of Power Quality, Wiley.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
SWAYAM: Power Quality, Prof. Bhim Singh, IIT Delhi, https://nptel.ac.in/courses/108102179
Power Quality in Power Distribution Systems, Dr. Mahesh Kumar, IIT Madras, https://nptel.ac.in/courses/108106025

EE405N SMART GRID TECHNOLOGIES (3-0-0) 3

Concepts of the smart grid, its drivers and functions; smart grid architecture and components; integration of distributed generation sources to the grid; open access and its implications. Instrumentation for the smart grid: intelligent electronic devices, smart meters and advanced metering infrastructure, communication techniques and protocols for smart grid applications, and smart substations. Sensing and measurement technologies including phasor measurement units and wide area measurement systems; wide area monitoring, protection and control techniques. Power quality issues in the smart grid and their management. Microgrids: architecture, grid-connected and islanded operation, control hierarchy and protection. Energy storage systems and their role in grid support. Demand side management and demand response programmes; decision support systems and asset management; power trade and electricity market economics; case studies on smart grid implementation in India and abroad; challenges and benefits of smart grid deployment, including interoperability, standards and cyber security.

Textbooks: M. Kamran, Fundamentals of Smart Grid Systems, Amsterdam, Netherlands: Academic Press, 2022.
N. D. Hatziargyriou, Microgrids: Architectures and Control, 1st ed. Chichester, U.K.: Wiley-IEEE Press, 2013.
M. Hossain and A. Mahmood, Renewable Energy Integration: Challenges and Solutions, 1st ed. Berlin, Germany: Springer-Verlag, 2014.
A. R. Messina, Wide Area Monitoring of Interconnected Power Systems, 1st ed. London, U.K.: IET, 2015.
S. Borlase, Ed., Smart Grids: Infrastructure, Technology and Solutions, Boca Raton, FL, USA: CRC Press, 2012.
Handbooks: C.-C. Liu, S. McArthur, and S.-J. Lee, Eds., Smart Grid Handbook, Wiley.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
SWAYAM: Smart Grid: Basics to Advanced Technologies, Prof. N. P. Padhy and Prof. Premalata Jena, IIT Roorkee, https://nptel.ac.in/courses/108107113
Introduction to Smart Grid, NPTEL, https://onlinecourses.nptel.ac.in/noc21_ee68/preview

EE406N BASIC DESIGN OF ROTATING ELECTRICAL MACHINES (3-0-0) 3

Introduction to electrical machine design: design factors, standard specifications, limitations imposed by saturation, temperature rise, insulation, efficiency and mechanical strength; modern trends in machine design and the role of computer-aided design. Materials used in electrical machines: conducting materials and their properties, magnetic materials, magnetisation characteristics, iron losses, permanent magnet materials, insulating materials and their classification by thermal class, and material selection criteria. Magnetic circuit calculations: magnetic circuit of a rotating machine, calculation of magnetomotive force for air gap and iron parts, Carter's coefficient, real and apparent flux densities, effect of slotting and ducts, leakage flux and leakage reactance estimation. Thermal considerations and cooling: heating and cooling curves, modes of heat dissipation, temperature rise calculation, rating of machines, continuous, short-time and intermittent ratings,

and methods of cooling of rotating machines. Output equation and main dimensions: specific electric and magnetic loadings, output coefficient, choice of main dimensions, separation of main dimensions and the effect of design parameters on performance and cost. Design of armature and field windings: types of windings, conductor sizing, choice of number of slots, slot design, current density, winding factors, and insulation design. Design of a three-phase induction motor: choice of specific loadings, stator design, choice of slot number and combinations, rotor design for squirrel cage and slip-ring machines, air gap length, end ring design, estimation of no-load current, leakage reactance, losses, efficiency, power factor and temperature rise, and prediction of the performance and torque-slip characteristics. Design of synchronous machines: output equation, choice of specific loadings, short circuit ratio and its significance, stator design, design of salient pole and cylindrical rotor field systems, damper windings and estimation of performance. Introduction to the design of DC machines and to permanent magnet machines; introduction to numerical field computation using the finite element method and to computer-aided design workflows for rotating machines.

Textbooks: A. K. Sawhney and A. Chakrabarti, A Course in Electrical Machine Design, 6th ed. New Delhi, India: Dhanpat Rai and Co., 2015.
M. G. Say, The Performance and Design of Alternating Current Machines, 3rd ed. New Delhi, India: CBS Publishers, 1983.
A. Shanmugasundaram, G. Gangadharan, and R. Palani, Electrical Machine Design Data Book, New Delhi, India: New Age International.
J. Pyrhonen, T. Jokinen, and V. Hrabovcova, Design of Rotating Electrical Machines, 2nd ed. Chichester, U.K.: Wiley, 2013.
V. N. Mittle and A. Mittal, Design of Electrical Machines, 5th ed. New Delhi, India: Standard Publishers Distributors.
Handbooks: I. Boldea and S. A. Nasar, The Induction Machines Design Handbook, 2nd ed., CRC Press.
H. W. Beaty and J. L. Kirtley Jr., Electric Motor Handbook, McGraw-Hill.
SWAYAM: Design of Electric Motors, NPTEL, https://onlinecourses.nptel.ac.in/noc23_ee140/preview
Computer-Aided Design of Electrical Machines, NPTEL,
https://onlinecourses.nptel.ac.in/noc25_ee14/preview

EE407N INTRODUCTION TO MODELLING OF ELECTRICAL MACHINES (3-0-0) 3

Principles for electrical machine analysis and magnetically coupled circuits: review of basic concepts, magnetizing inductance, and modelling of linear and non-linear magnetic circuits. Reference frame theory and transformation of vectors: concept of the space vector and its components, direct and quadrature axis variables, types of transformation and the condition for power invariance, zero-sequence component, expressions for power under various types of transformation, transformations between reference frames, Clarke and Park transformations, variables observed from various reference frames, and simulation studies. Theory and modelling of the symmetrical induction machine: voltage and torque in machine variables, derivation of the dq0 model for a symmetrical induction machine, voltage and torque equations in arbitrary reference frame variables, analysis of steady-state operation and simulation studies. Theory and modelling of the synchronous machine: voltage and torque in machine variables, derivation of the dq0 model for a salient pole synchronous machine, stator voltage equations in the arbitrary reference frame, voltage equations in the rotor reference frame, analysis of steady-state operation and simulation studies.

Textbooks: P. C. Krause, O. Wasynczuk, and S. D. Sudhoff, Analysis of Electric Machinery and Drive Systems, 3rd ed. Hoboken, NJ, USA: Wiley-IEEE Press, 2013.
R. Krishnan, Electric Motor Drives: Modelling, Analysis and Control, 1st ed. Noida, India: Pearson Education India, 2015.
C.-M. Ong, Dynamic Simulation of Electric Machinery Using MATLAB/Simulink, 1st ed. Upper Saddle River, NJ, USA: Prentice Hall, 1997.
M. F. Rahman and S. K. Dwivedi, Modelling, Simulation and Control of Electrical Drives, 1st ed. London, U.K.: Institution of Engineering and Technology, 2019.
Handbooks: H. W. Beaty and J. L. Kirtley Jr., Electric Motor Handbook, McGraw-Hill.

B. K. Bose, Ed., Power Electronics and Motor Drives: Advances and Trends, Academic Press.
SWAYAM: Modelling and Analysis of Electric Machines, NPTEL, https://nptel.ac.in/courses/108106023
Power System Dynamics, Control and Monitoring, NPTEL,
https://onlinecourses.nptel.ac.in/noc21_ee16/preview

EE408N ADVANCED POWER ELECTRONICS (3-0-0) 3

Advanced DC-DC converters: review of basic dc-dc converters, Luo converters and their applications, active and passive clamps for flyback and forward converters, review of the full bridge converter, and phase shifted full bridge and dual active bridge dc-dc converters. Resonant dc-dc converters: review of resonant circuit theory covering LC resonance, series and parallel resonance and series-parallel (LLC) resonant circuits; soft switching techniques comprising zero voltage switching and zero current switching; classification of resonant dc-dc converters into series and parallel resonant converters, quasi-resonant converters and multi-resonant converters. Advanced AC-DC converters or active rectifiers and power factor correction converters: review of power factor, boost PFC converters including semi-boost, dual boost and totem-pole topologies, buck PFC converters, and control of PFC converters. Advanced DC-AC converters: review of inverters, current source inverters, advanced PWM techniques including space vector PWM and third harmonic injected PWM, resonant inverters, PWM techniques for multilevel inverters and advanced multilevel inverter topologies.

Textbooks: F. L. Luo and H. Ye, Advanced DC/DC Converters, 2nd ed. Boca Raton, FL, USA: CRC Press, 2016.
B. Wu and M. Narimani, Advanced Power Electronics Converters: PWM Converters Processing AC Voltages, Hoboken, NJ, USA: Wiley-IEEE Press, 2014.
M. K. Kazimierczuk and D. Czarkowski, Resonant Power Converters, 2nd ed. Hoboken, NJ, USA: Wiley, 2011.
E. Kabalci, Multilevel Inverters: Introduction and Emergent Topologies, Amsterdam, Netherlands: Academic Press, 2021.
N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications and Design, 3rd ed. Hoboken, NJ, USA: Wiley, 2003.
A. M. Trzynadlowski, Introduction to Modern Power Electronics, 3rd ed. Hoboken, NJ, USA: Wiley, 2015.
Handbooks: M. H. Rashid, Ed., Power Electronics Handbook, 4th ed., Butterworth-Heinemann.
ON Semiconductor, Power Factor Correction (PFC) Handbook, Rev. 3, ON Semiconductor.
SWAYAM: Advance Power Electronics, Prof. Bhim Singh, IIT Delhi,
https://onlinecourses.nptel.ac.in/noc25_ee02/preview
Advance Power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee,
https://onlinecourses.nptel.ac.in/noc20_ee28/preview

EE409N NONLINEAR AND OPTIMAL CONTROL (3-0-0) 3

Introduction to nonlinear systems: types of nonlinearities, limitations of linear control theory, phase-plane analysis, classification of singular points, linearization, the describing function method, limit cycles and Lienard systems. Lyapunov stability and system analysis: stability concepts covering Lyapunov, asymptotic and exponential stability, Lyapunov's direct method, LaSalle's invariance principle, construction of Lyapunov functions, Krasovskii's method and control Lyapunov functions. Nonlinear control design techniques: feedback linearization, input-output linearization, relative degree and zero dynamics, backstepping design, an overview of adaptive backstepping, sliding mode control design and analysis, and chattering reduction. Optimal control fundamentals: formulation of optimal control problems, calculus of variations, the Euler-Lagrange equation, transversality conditions, Pontryagin's maximum principle, Hamiltonian formulation, and bang-bang and singular controls. Dynamic programming and the linear quadratic regulator: Bellman's principle of optimality, the Hamilton-Jacobi-Bellman equation, the linear quadratic regulator, Riccati equations, finite and infinite horizon control, and comparison between the maximum principle and dynamic programming approaches. Advanced topics and applications: nonlinear observers and the extended Kalman filter, robust nonlinear control, an introduction to H-infinity methods, and applications in autonomous systems, robotics, aerospace and trajectory optimization.

Textbooks: H. K. Khalil, Nonlinear Systems, 3rd ed. Noida, India: Pearson Education India.
D. S. Naidu, Optimal Control Systems, 1st ed. Chennai, India: Yesdee Publishing (CRC Press Indian Edition).
J.-J. E. Slotine and W. Li, Applied Nonlinear Control, Englewood Cliffs, NJ, USA: Prentice Hall, 1991.
D. E. Kirk, Optimal Control Theory: An Introduction, Mineola, NY, USA: Dover Publications, 2004.
F. L. Lewis, D. Vrabie, and V. L. Syrmos, Optimal Control, 3rd ed. Hoboken, NJ, USA: Wiley, 2012.
Handbooks: W. S. Levine, Ed., The Control Handbook, 2nd ed., CRC Press.
R. C. Dorf, Ed., The Electrical Engineering Handbook, CRC Press.
SWAYAM: Nonlinear System Analysis, NPTEL, https://onlinecourses.nptel.ac.in/noc20_ee54/preview
Nonlinear Dynamical Systems and Control, Prof. Vijaysekhar Chellaboina, NPTEL, https://onlinecourses.nptel.ac.in/noc24_ee128/preview

EE410N ROBOT MODELLING AND CONTROL (2-0-2) 3

Introduction and forward kinematics: robot classifications, coordinate frames, homogeneous transformations, the Denavit-Hartenberg convention and forward kinematics of serial manipulators. Inverse kinematics: analytical and numerical solutions, multiple solutions, workspace, singularities and inverse kinematics for planar and spatial manipulators. Velocity kinematics and Jacobians: linear and angular velocities, velocity propagation, derivation of the Jacobian matrix, singular configurations and velocity control concepts. Robot dynamics: kinetic and potential energy of manipulators, the Lagrangian formulation, dynamic equations of motion, the inertia matrix, Coriolis and centrifugal terms, the gravity vector and an overview of the Newton-Euler method. Trajectory planning: trajectory planning in joint space, cubic and quintic polynomials and basics of Cartesian trajectory generation. Independent joint control: PD and PID joint control, decoupled control strategy, gravity compensation and the influence of dynamics on joint control. Laboratory exercises to supplement the course.

Textbooks: M. W. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modelling and Control, Hoboken, NJ, USA: Wiley, 2006.
J. J. Craig, Introduction to Robotics: Mechanics and Control, 4th ed. Upper Saddle River, NJ, USA: Pearson, 2017.
P. Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, 2nd ed. Cham, Switzerland: Springer, 2017.
B. Siciliano, L. Sciavicco, L. Villani, and G. Oriolo, Robotics: Modelling, Planning and Control, London, U.K.: Springer, 2009.
Handbooks: B. Siciliano and O. Khatib, Eds., Springer Handbook of Robotics, 2nd ed., Springer.
S. Y. Nof, Ed., Handbook of Industrial Robotics, 2nd ed., Wiley.
SWAYAM: Robotics: Basics and Selected Advanced Concepts, NPTEL, https://onlinecourses.nptel.ac.in/noc26_me01/preview
Mechanics and Control of Robotic Manipulators, NPTEL, https://onlinecourses.nptel.ac.in/noc22_me93/preview

EE411N DEEP NEURAL NETWORKS (2-0-2) 3

Foundations of deep learning: evolution of neural networks, historical context and key breakthroughs; the perceptron and multi-layer perceptron covering architecture and representation power; activation functions including sigmoid, tanh, ReLU, leaky ReLU and softmax; the perceptron learning algorithm and backpropagation. Optimization and regularization techniques: gradient descent and its variants comprising stochastic gradient descent, momentum, AdaGrad, RMSprop and Adam; weight initialization techniques; regularization using L2 norm, dropout, early stopping and noisy data augmentation; the bias-variance tradeoff and handling of overfitting. Dimensionality reduction and autoencoders: principal component analysis and its relation to autoencoders; autoencoder architectures including basic, sparse, denoising and variational autoencoders; use cases in anomaly detection and feature extraction; implementation of PCA and autoencoders using PyTorch or TensorFlow with visualization of encoded and reconstructed data. Convolutional and recurrent neural networks: CNN architectures covering convolution, pooling, padding and

normalization; key models including AlexNet, VGGNet, InceptionNet and ResNet; recurrent neural networks and their variants LSTM and GRU together with the vanishing and exploding gradient problems; applications in image classification, object detection and sequence modelling. Deep learning applications and mini project: applications in computer vision and natural language processing; sensor data analysis, sentiment analysis and image segmentation; a brief introduction to attention mechanisms and transformers; and integration of deep neural networks with edge devices and real-time systems. Laboratory exercises to supplement the course.

Textbooks: I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, Cambridge, MA, USA: MIT Press, 2016.
C. M. Bishop, Pattern Recognition and Machine Learning, New York, NY, USA: Springer, 2006.
B. Yegnanarayana, Artificial Neural Networks, New Delhi, India: PHI Learning, 2009.
S. Haykin, Neural Networks and Learning Machines, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2009.
G. H. Golub and C. F. Van Loan, Matrix Computations, 4th ed. Baltimore, MD, USA: Johns Hopkins University Press, 2013.
J. C. Principe, N. R. Euliano, and W. C. Lefebvre, Neural and Adaptive Systems, Hoboken, NJ, USA: Wiley, 2000.
R. O. Duda, P. E. Hart, and D. G. Stork, Pattern Classification, 2nd ed. Hoboken, NJ, USA: Wiley, 2001.
Handbooks: J. Kacprzyk and W. Pedrycz, Eds., Springer Handbook of Computational Intelligence, Springer.
E. Fiesler and R. Beale, Eds., Handbook of Neural Computation, Oxford University Press.
SWAYAM: Deep Learning, Prof. Mitesh M. Khapra, IIT Madras, https://nptel.ac.in/courses/106106184
Deep Learning - Part 2, IIT Madras, https://nptel.ac.in/courses/106106201

EE412N TIME SERIES ANALYSIS AND FORECASTING (2-1-0) 3

Background for time series data analysis and forecasting: examples of time series data, numerical description of time series data, use of data transformations and adjustments, general approach to time series modelling and forecasting, and evaluating and monitoring forecasting model performance. Regression analysis and forecasting: least squares estimation in linear regression models, statistical inference in linear regression, regression models for general time series data, model adequacy checking and exponential smoothing methods. Autoregressive integrated moving average models: finite order autoregressive process AR(p), finite order moving average process MA(q), mixed autoregressive-moving average processes, the autocorrelation and partial autocorrelation functions of an ARMA(p, q) process, examples of ARIMA(p, d, q) processes and forecasting of ARIMA processes. Other forecasting methods: multivariate time series models and forecasting, ARCH and GARCH models, state space models and the Kalman filter, and neural networks for forecasting.

Textbooks: D. C. Montgomery, C. L. Jennings, and M. Kulahci, Introduction to Time Series Analysis and Forecasting, 2nd ed. Hoboken, NJ, USA: Wiley, 2015.
R. H. Shumway and D. S. Stoffer, Time Series Analysis and Its Applications with R Examples, 2nd ed. New York, NY, USA: Springer, 2006.
C. Chatfield, Time-Series Forecasting, Boca Raton, FL, USA: Chapman and Hall/CRC, 2000.
G. E. P. Box, G. M. Jenkins, and G. C. Reinsel, Time Series Analysis: Forecasting and Control, Upper Saddle River, NJ, USA: Prentice Hall, 1994.
R. Yaffee and M. McGee, Introduction to Time Series Analysis and Forecasting with Applications of SAS and SPSS, San Diego, CA, USA: Academic Press, 2000.
W. W. S. Wei, Time Series Analysis: Univariate and Multivariate Methods, 2nd ed. Boston, MA, USA: Pearson, 2006.
Handbooks: B. Schelter, M. Winterhalder, and J. Timmer, Eds., Handbook of Time Series Analysis, Wiley-VCH.
D. Zwillinger and S. Kokoska, CRC Standard Probability and Statistics Tables and Formulae, CRC Press.
SWAYAM: Applied Time-Series Analysis, IIT Madras, https://nptel.ac.in/courses/103106123
Time Series Modelling and Forecasting with Applications in R, IIT Bombay,
https://onlinecourses.nptel.ac.in/noc25_cs71/preview

EE413N AI-DRIVEN IOT SYSTEMS (2-0-2) 3

IoT architecture and sensor integration: overview of the IoT ecosystem covering sensing, connectivity and data analytics; interfacing of sensors and actuators with microcontrollers such as Arduino and ESP32; signal conditioning and analog-to-digital conversion concepts for IoT integration; interfacing of temperature, motion and pressure sensors and construction of a simple IoT-enabled sensor dashboard. Communication protocols and edge computing: wired and wireless communication using UART, SPI, I2C, BLE, Zigbee and WiFi; MQTT, CoAP and HTTP protocols for data transmission; edge versus cloud computing with their benefits and trade-offs; building an MQTT-based sensor communication system with data logging and visualization using Node-RED and ThingSpeak. Data preprocessing and embedded AI: sensor data cleaning, noise filtering and normalization; time-series data handling and feature extraction; introduction to TinyML and the deployment of AI models on microcontrollers; building a basic embedded AI classifier and real-time prediction from sensor inputs using pre-trained models. Deep learning for smart IoT applications: use of convolutional neural networks for image-based IoT sensors in applications such as surveillance and fire detection; use of recurrent neural networks for time-series prediction in fault detection and anomaly monitoring; integration of sensor network outputs with deep neural networks for edge decisions; image classification using ESP32-CAM with TensorFlow Lite and sequence forecasting with LSTM for temperature and humidity trends. IoT use cases and mini projects: smart healthcare including fall detection and vital monitoring; environmental monitoring of pollution, water level and weather patterns; industrial IoT for predictive maintenance and safety monitoring; and an end-to-end mini project covering sensing, transmission, cloud interface and AI analytics. Laboratory exercises to supplement the course.

Textbooks: O. Hersent, D. Boswarthick, and O. Elloumi, The Internet of Things: Key Applications and Protocols, Hoboken, NJ, USA: Wiley, 2012.
B. Yegnanarayana, Artificial Neural Networks, New Delhi, India: PHI Learning, 2009.
I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, Cambridge, MA, USA: MIT Press, 2016.
R. Buyya and A. V. Dastjerdi, Eds., Internet of Things: Principles and Paradigms, Amsterdam, Netherlands: Elsevier, 2016.
P. Warden and D. Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, Sebastopol, CA, USA: O'Reilly, 2019.
S. Haykin, Neural Networks and Learning Machines, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2009.
Handbooks: J. Fraden, Handbook of Modern Sensors: Physics, Designs and Applications, Springer.
J. Kacprzyk and W. Pedrycz, Eds., Springer Handbook of Computational Intelligence, Springer.
SWAYAM: Introduction to Internet of Things, Prof. Sudip Misra, IIT Kharagpur,
https://nptel.ac.in/courses/106105166
Introduction to Industry 4.0 and Industrial Internet of Things, IIT Kharagpur,
(https://nptel.ac.in/courses/106105195)

EE415N ELECTRIC POWER SYSTEM (2-1-0) 3

Electrical energy sources, power network structure and its components. per unit representation, single-line diagram representation. AC, AC-DC, and DG- based systems, forms of field energy, concepts of real and reactive powers and their conventions. Power system operation and control: State of operation of a power system, voltage and frequency control mechanisms, power generation, Introduction to tariff structure. Transmission lines: Design, Modelling and performance analysis. Cables, insulators, grounding and safety. System Modelling. Steady state analysis: power flow – NR Method. balanced and unbalanced short circuit analysis. Stability analysis: Classification, rotor angle stability of SMIB -- solution method using equal-area criteria.

Textbooks: John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994.
P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.
Handbooks: A. R. Bergen and V. Vittal, "Power Systems Analysis", Prentice-Hall, 2000.
J. D. Glover, T. J. Overbye and M. S. Sarma, "Power System Analysis & Design", Cengage Learning, 2015.

SWAYAM: Prof. Debapriya Das, "Power System Analysis", IIT Kharagpur.
https://onlinecourses.nptel.ac.in/noc19_ee62/preview

EE451N FLEXIBLE AC TRANSMISSION SYSTEMS (3-0-0) 3

Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS, FACTS control considerations and classification of FACTS controllers. Principles of shunt compensation using variable impedance type and switching converter type controllers; the static synchronous compensator (STATCOM), its configuration, characteristics and control. Principles of static series compensation using the GTO controlled series capacitor (GCSC), thyristor controlled series capacitor (TCSC) and thyristor switched series capacitor (TSSC), their applications, and the static synchronous series compensator (SSSC). Principles of operation, steady state model and characteristics of static voltage regulators and phase shifters together with their power circuit configurations. The unified power flow controller (UPFC): principles of operation and characteristics, independent active and reactive power flow control, and comparison of the UPFC with controlled series compensators and phase shifters.

Textbooks: N. G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, New York, NY, USA: IEEE Press, 2000.
Y. H. Song and A. T. Johns, Flexible AC Transmission Systems (FACTS), London, U.K.: Institution of Electrical Engineers Press, 1999.
R. M. Mathur and R. K. Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Hoboken, NJ, USA: IEEE Press, Wiley Interscience, 2002.
K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, 1st ed. New Delhi, India: New Age International Publishers, 2007.
Handbooks: M. H. Rashid, Ed., Power Electronics Handbook, 4th ed., Butterworth-Heinemann.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
SWAYAM: Power Electronics Applications in Power Systems, NPTEL,
https://onlinecourses.nptel.ac.in/noc24_ee130/preview
Advance Power Electronics, Prof. Bhim Singh, IIT Delhi,
https://onlinecourses.nptel.ac.in/noc25_ee02/preview

EE452N POWER ELECTRONICS FOR HVDC AND FACTS APPLICATIONS (3-0-0) 3

Fundamentals of HVDC transmission systems: introduction to HVDC technology, the need for HVDC transmission, classification of DC links, advantages and limitations of HVDC systems, comparison between EHVAC and HVDC transmission, applications of HVDC, modern trends in HVDC and components of HVDC converter stations. HVDC converter topologies and control: overview of power electronic converters, three-phase converter circuits covering working, waveforms and analysis, pulse number and harmonics, harmonic analysis and filtering, cascading and parallel operation of converters, converter transformer design and performance, converter control characteristics including current control and extinction angle control, introduction to voltage source converters with their principles and advantages, modular multilevel converters covering structure and operation, and protection schemes in converter circuits. Power transmission issues and enhancement strategies: emerging issues in AC transmission systems, power system stability and controllability, transmission system compensation techniques comprising shunt, series and combined compensation, introduction to flexible AC transmission systems, objectives and benefits of FACTS, basic types of FACTS controllers including series, shunt and series-shunt configurations, comparison of HVDC and FACTS, integration of FACTS with renewable energy systems, and operational challenges and reliability aspects. FACTS controllers: thyristor-controlled FACTS devices and converter-based FACTS controllers; the static VAR compensator (SVC), its operation and analysis; and the thyristor-controlled series capacitor (TCSC), its operation and analysis.

Textbooks: K. R. Padiyar, HVDC Power Transmission Systems: Technology and System Interactions, New Delhi, India: New Age International Publishers, 2005.

P. Kundur, Power System Stability and Control, New York, NY, USA: McGraw-Hill Education, 1994.
N. G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, New York, NY, USA: IEEE Press, 2000.
R. M. Mathur and R. K. Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Piscataway, NJ, USA: IEEE Press, 2002.
J. Arrillaga, High Voltage Direct Current Transmission, 2nd ed. London, U.K.: Institution of Electrical Engineers, 1998.
Handbooks: M. H. Rashid, Ed., Power Electronics Handbook, 4th ed., Butterworth-Heinemann.
D. G. Fink and H. W. Beaty, Standard Handbook for Electrical Engineers, McGraw-Hill.
SWAYAM: High Voltage DC Transmission, NPTEL, https://nptel.ac.in/courses/108104013
Power Electronics Applications in Power Systems, NPTEL,
https://onlinecourses.nptel.ac.in/noc24_ee130/preview

EE453N SIMULATION AND CONTROL OF POWER ELECTRONIC CONVERTERS (2-0-2) 3

Modelling and control of dc-dc converters: review of dynamic modelling of dc-dc converters using state space averaging and small signal modelling for both non-isolated and isolated topologies; dc-dc converter transfer functions and frequency domain analysis; controller design for dc-dc converters using current mode and voltage mode control with type I, type II and type III compensators; control of non-minimum phase dc-dc converters; analog and digital implementation; and advanced control of dc-dc converters. Modelling and control of voltage source inverters: converter switched and average models of the half bridge inverter; averaged model of the non-ideal half bridge inverter; control of the half bridge inverter using PI and PR controllers; feedforward compensation; Clarke and Park transformations; modelling and control of the two-level voltage source converter using alpha-beta and d-q frame based control; grid feeding and grid forming control; and phase locked loops. Laboratory exercises to supplement the course.

Textbooks: R. Teodorescu, M. Liserre, and P. Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, Hoboken, NJ, USA: Wiley-IEEE Press, 2011.
A. Yazdani and R. Iravani, Voltage-Sourced Converters in Power Systems: Modelling, Control and Applications, Hoboken, NJ, USA: Wiley-IEEE Press, 2010.
M. B. Patil, Simulation of Power Electronic Circuits, Oxford, U.K.: Alpha Science International Ltd., 2009.
F. Blaabjerg, Ed., Control of Power Electronic Converters and Systems, Vol. 1, Amsterdam, Netherlands: Academic Press, 2017.
M. P. Kazmierkowski, R. Krishnan, and F. Blaabjerg, Control in Power Electronics: Selected Problems, San Diego, CA, USA: Academic Press, 2002.
S. Bacha, I. Munteanu, and A. I. Bratcu, Power Electronic Converters Modelling and Control, London, U.K.: Springer, 2014.
H. Akagi, E. H. Watanabe, and M. Aredes, Instantaneous Power Theory and Applications to Power Conditioning, Hoboken, NJ, USA: Wiley-IEEE Press, 2007.
N. Mohan, Power Electronics: A First Course, Hoboken, NJ, USA: Wiley, 2011.
Handbooks: M. H. Rashid, Ed., Power Electronics Handbook, 4th ed., Butterworth-Heinemann.
R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, Springer.
SWAYAM: Control and Tuning Methods in Switched Mode Power Converters, NPTEL, https://onlinecourses.nptel.ac.in/noc21_ee104/preview
Digital Control in Switched Mode Power Converters and FPGA-based Prototyping, NPTEL, https://onlinecourses.nptel.ac.in/noc22_ee124/preview

EE454N HIGH POWER CONVERTERS FOR ELECTRICAL DRIVES (3-0-0) 3

Introduction to the two-level voltage source inverter and modulation techniques: review of two-level inverters and their PWM schemes, effect of dead-time and its compensation in two-level inverters, limitations of two-level inverters and introduction to multilevel inverters, conventional multilevel inverter topologies, sinusoidal PWM, harmonic content, over-modulation, third harmonic injection PWM, space vector modulation, switching

states and space vectors, dwell time calculation, modulation index, switching sequence, spectrum analysis and even-order harmonic elimination. Cascaded H-bridge multilevel inverters: bipolar and unipolar pulse width modulation, multilevel inverter topologies, the CHB inverter with equal dc voltages, H-bridges with unequal dc voltages, phase shifted multicarrier modulation, level shifted multicarrier modulation and comparison between phase-shifted and level-shifted PWM schemes. Diode clamped multilevel inverters: the three-level inverter, space vector modulation, neutral-point voltage control, carrier-based PWM schemes with neutral-point voltage control, other space vector modulation algorithms, high-level diode-clamped inverters and the NPC/H-bridge inverter. PWM current source inverters and rectifiers: parallel current source inverters and the load-commutated inverter, single-bridge current source rectifier, dual-bridge current source rectifier, active damping control and power factor control.

Textbooks: B. Wu and M. Narimani, High-Power Converters and AC Drives, 2nd ed. Hoboken, NJ, USA: Wiley, 2017.
H. Abu-Rub, A. Iqbal, and J. Guzinski, High Performance Control of AC Drives with MATLAB/Simulink, 2nd ed. Chichester, U.K.: Wiley, 2021.
S. Du, A. Dekka, B. Wu, and N. Zargari, Modular Multilevel Converters: Analysis, Control and Applications, Hoboken, NJ, USA: Wiley-IEEE Press, 2018.
N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications and Design, 3rd ed. Hoboken, NJ, USA: Wiley, 2003.
Handbooks: M. H. Rashid, Ed., Power Electronics Handbook, 4th ed., Butterworth-Heinemann.
B. K. Bose, Ed., Power Electronics and Motor Drives: Advances and Trends, Academic Press.
SWAYAM: High Power Multilevel Converters: Analysis, Design and Operational Issues, IIT Delhi, https://nptel.ac.in/courses/108102157
Advance Power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee, https://onlinecourses.nptel.ac.in/noc20_ee28/preview

EE455N POWER CONVERTERS FOR EV CHARGING (2-1-0) 3

Introduction to transportation electrification and EV powertrains: overview of transportation electrification and its impact on the power grid, electric vehicle powertrain architecture covering motor drives, batteries, converters and control systems, and introduction to electric vehicle charging infrastructure comprising onboard and offboard systems. Wireless power transfer systems: basics of wireless power transfer for electric vehicle charging, operating principles based on coupled inductor and transformer models, coil types and geometries including circular, rectangular and double-D structures, compensation techniques such as series-series and parallel-series compensation, circuit analysis covering gain, input impedance and efficiency, and design aspects and control of series-series and parallel-series wireless power transfer systems. Conductive charging and front-end power conversion: conventional conductive electric vehicle charging systems, their architecture and classification, power conversion stages from the grid interface to battery charging, introduction to power factor correction and its role in electric vehicle chargers, and harmonic compliance and efficiency optimization in front-end conversion. Isolated dc-dc converters and advanced control: the role of isolated dc-dc converters in electric vehicle charging systems, resonant converter topologies including series, parallel and LLC configurations, operation of unidirectional isolated dc-dc converters, the phase-shifted full-bridge isolated buck converter, and control strategies for voltage regulation and feedback loops.

Textbooks: C. Mi, M. A. Masrur, and D. W. Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd ed. Chichester, U.K.: Wiley, 2017.
C. Mi and C. T. Rim, Wireless Power Transfer for Electric Vehicles and Mobile Devices, Chichester, U.K.: John Wiley and Sons, 2017.
T. Imura, Wireless Power Transfer Using Magnetic and Electric Resonance Coupling Techniques, Singapore: Springer, 2020.
A. Emadi, Ed., Advanced Electric Drive Vehicles, Boca Raton, FL, USA: CRC Press, 2015.
N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications and Design, 3rd ed. Hoboken, NJ, USA: Wiley, 2003.

Handbooks: M. H. Rashid, Ed., Power Electronics Handbook, 4th ed., Butterworth-Heinemann.
A. Emadi, Ed., Handbook of Automotive Power Electronics and Motor Drives, CRC Press.
SWAYAM: Charging Infrastructure, NPTEL, https://onlinecourses.nptel.ac.in/noc25_ee134/preview
Electric Vehicles and Renewable Energy, Prof. Ashok Jhunjhunwala, IIT Madras,
(https://nptel.ac.in/courses/108106182)

EE456N POWER ELECTRONICS IN POWER CONTROL (2-1-0) 3

Devices: Characteristics- diode, BJT, IGBT, MOSFET, IPMs, Thyristor based devices: SCRs/TRIAC/GTOs. Reactive elements: capacitors, inductor, transformer, pulse transformer. Data sheets, switching and conduction losses, heat dissipation- heat sink, loss calculation. Drive circuit, current and voltage sensors, opto-couplers. Functional classification of converters: DC-DC converters - switched mode buck converter, switched mode boost converter: control circuit, snubber, applications. Inverters: H-Bridge, single-phase, three-phase inverters. Rectifiers: single-phase and three-phase rectifiers. AC power controllers. Simulations of power electronic converters.

Textbooks: D. W. Hart, Power Electronics, New York, NY, USA: McGraw-Hill, 2010.
N. Mohan, T. Undeland, W. Robbins, Power Electronics: Converters Applications and Design, New York: Wiley, 1995.
M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, 2nd ed., Englewood Cliffs, NJ: Prentice Hall.
L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Kluwer Academic Publisher.
Handbooks: P. C. Sen, Modern Power Electronics, S. Chand & Company Ltd., New Delhi, 2nd Edition.
SWAYAM: L. Umanand. Fundamental of Power Electronics, SWAYAM–NPTEL IISc Bangalore,
https://onlinecourses.swayam2.ac.in/ntr25_ed137/preview

EE398N/ EE448N/ EE498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

EE399N MAJOR PROJECT - I (0-0-18) 9

The student shall carry out an independent project of a design, analytical, experimental, or computational nature under the guidance of a faculty member of the Department. The work shall include a survey of the relevant literature, formulation of objectives, execution of the proposed methodology, analysis and interpretation of results, and documentation. The student shall submit a project proposal at the commencement of the semester, present periodic progress reviews as prescribed by the Department, and submit a comprehensive project report at the end of the semester. Evaluation shall be based on periodic reviews, the quality and extent of the work carried out, the final report, and a viva-voce examination conducted by the departmental committee. Internship and Major Project are mutually exclusive in a given semester.

EE449N MAJOR PROJECT - II (0-0-18) 9

EE499N MAJOR PROJECT - III (0-0-18) 9

Department of Electronics and Communication Engineering (EC)
Bachelor of Technology in Electronics and Communication Engineering

Basic Science Courses (BSC)

CY100N	Engineering Chemistry	(3-0-2)4
MA103N	Linear Algebra	(3-0-0)3
MA107N	Multivariable Calculus	(3-0-0)3
PH150N	Engineering Physics	(3-0-2)4
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

CS100N	Computer Programming (C)	(0-0-6)3
DE100N	Design Thinking and Prototyping	(2-0-2)3
UC100N	Data Science and AI	(2-0-2)3
UC101N	Introduction to Engineering	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC)

EC200N	Analog Communication	(2-1-0)3
EC201N	Digital System Design	(2-1-0)3
EC202N	Circuits, Systems and Signals	(2-1-0)3
EC203N	Probability and Random Processes	(2-1-0)3
EC204N	Analog Communication Lab	(0-0-3)1.5
EC205N	Digital System Design Lab	(0-0-3)1.5
EC250N	Electromagnetic Waves and Transmission Lines	(2-1-0)3
EC251N	Analog Electronics	(2-1-0)3
EC252N	Digital Signal Processing	(2-1-0)3
EC253N	Microprocessor based Systems	(2-1-0)3
EC254N	Microprocessor Lab	(0-0-2)1
EC255N	Digital Signal Processing Lab	(0-0-2)1
EC256N	Analog Electronics Lab	(0-0-3)1.5
EC300N	Control Systems and Automation	(2-1-0)3
EC301N	VLSI Design	(2-1-0)3
EC302N	Digital Communication	(2-1-0)3
EC303N	Foundations of Machine Learning	(2-1-0)3
EC304N	RF Components and Circuits	(2-1-0)3
EC305N	VLSI Design Lab	(0-0-2)1
EC306N	Digital Communication Lab	(0-0-3)1.5

Dept/Institute Elective Courses (DEC)

EC352N	Computer Organization and Architecture	(3-0-0)3
EC353N	Computer Arithmetic	(3-0-0)3
EC354N	Embedded System Design	(2-0-2)3
EC355N	FPGA based System Design	(2-0-2)3
EC356N	Analog Integrated Circuits	(3-0-0)3
EC357N	Data Structures and Algorithms	(2-0-2)3
EC358N	Speech and Audio Processing	(3-0-0)3
EC359N	Image and Video Processing	(3-0-0)3
EC360N	Numerical Analysis and Computing	(3-0-0)3
EC361N	Satellite Communications	(3-0-0)3
EC362N	Principles of Modern Radar and Techniques	(3-0-0)3
EC363N	Communication Networks	(3-0-0)3
EC364N	Wireless Mobile Communication	(3-0-0)3
EC365N	Information Theory and Coding	(3-0-0)3
EC366N	Adhoc and Sensor Networks	(3-0-0)3
EC367N	Multimedia Communication Techniques	(3-0-0)3
EC368N	Software Defined and Cognitive Radio	(3-0-0)3
EC369N	Machine Learning for Wireless Communication Systems	(3-0-0)3
EC370N	Sparse Representations and Compressive Sensing	(3-0-0)3
EC371N	Deep Reinforcement Learning	(3-0-0)3
EC402N	VLSI CAD	(3-0-0)3
EC403N	Mixed Signal Design	(3-0-0)3
EC404N	Advanced Computer Architecture	(3-0-0)3
EC405N	VLSI Testing and Testability	(3-0-0)3
EC406N	Synthesis and Optimization of Digital Circuits	(3-0-0)3
EC407N	Techniques in Low Power VLSI	(3-0-0)3
EC408N	Submicron Devices	(3-0-0)3
EC409N	Active Filters	(3-0-0)3
EC410N	Heterogeneous and Parallel Computing	(2-0-2)3
EC411N	Algorithms and Architectures for Signal Processing	(3-0-0)3
EC412N	Advanced Digital Signal Processing	(3-0-0)3
EC413N	Real Time Signal Processing	(2-0-2)3
EC414N	Fourier and Wavelet Signal Processing	(3-0-0)3
EC415N	Mathematical Methods for Signal and Data Processing	(3-0-0)3
EC416N	Data Compression and Applications	(3-0-0)3
EC417N	Dynamical Systems, Chaos and Fractals	(3-0-0)3
EC418N	Statistical Analysis	(3-0-0)3
EC419N	Optimization Theory and Techniques	(3-0-0)3
EC420N	Unsupervised Learning	(3-0-0)3
EC421N	Spread Spectrum Communication	(3-0-0)3
EC422N	Error Control Coding	(3-0-0)3
EC423N	Optical Communication Systems and Networks	(3-0-0)3
EC424N	Radar Signal Processing	(3-0-0)3
EC425N	Algorithms for Parameter and State Estimation	(3-0-0)3
EC452N	Detection and Estimation Theory	(3-0-0)3
EC453N	Advanced Topics in Communication Engineering	(3-0-0)3
EC454N	Introduction to Photonics	(3-0-0)3
EC455N	MIMO Communication Systems	(3-0-0)3
EC456N	RF IC Design	(3-0-0)3

EC457N	Principles of Modern Radar-Advanced Techniques	(3-0-0)3
EC458N	Electronic Defence Systems	(3-0-0)3
EC459N	Millimeter Wave Communication	(3-0-0)3
EC460N	Computational Inverse Problems and Imaging	(3-0-0)3
EC461N	Advanced Deep Learning and Applications	(2-0-2)3
EC462N	Mathematics of Data Science	(3-0-0)3
EC463N	Antennas for Wireless Communications	(3-0-0)3
EC464N	Quantum Information Processing	(3-0-0)3
EC465N	Quantum Electronics	(3-0-0)3
EC466N	Quantum Neural Networks	(2-0-2)3
EC467N	Introduction to Gen AI	(2-0-2)3

Internships/Major Project Courses (IPC)

EC398N	Internship - I	(0-0-18)9
EC399N	Major Project - I	(0-0-18)9
EC448N	Internship – II	(0-0-18)9
EC449N	Major Project – II	(0-0-18)9
EC498N	Internship – III	(0-0-18)9
EC499N	Major Project - III	(0-0-18)9

Honors (Optional)

Students seeking an Honors degree shall credit a minimum of 15 additional credits from Postgraduate courses offered by the respective Department, as decided by the DUGC.

Suggested Plan of Study for B.Tech. in Electronics and Communication Engineering:

Slot/ Semester	I	II	III	IV	V	VI	VII	VIII
1	CY100N	PH150N	EC200N	EC250N	EC300N	EC398N / EC399N	EC448N / EC449N	EC498N / EC499N
2	MA107N	MA103N	EC201N	EC251N	EC301N	DEC	DEC	DEC
3	DE100N	CS100N	EC202N	EC252N	EC302N	DEC	DEC	DEC
4	UC100N	UC101N	EC203N	EC253N	EC303N	DEC	DEC	
5	UC103N	UC102N	EC204N	EC254N	EC304N			
6	PL1XWN/ PL1X9N	PL1YWN/ PL1Y9N	EC205N	EC255N	EC305N			
7			PL2XWN/ PL2X9N	EC256N	EC306N			
8				PL2YWN/PL2Y9N	PL3XWN/PL3X9N			

Requirements for B.Tech. in Electronics and Communication Engineering:

Category of Courses	Minimum Credits to be Earned
Foundation Courses Basic Science Courses (BSC): 20 General Engineering Courses (GEC): 12	32
Programme Core Courses (PCC)	48
Department/Institute Elective Courses (DEC)	24
Internships/Major Project Courses (IPC)	27
Life Skill Courses (LSC)	20
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
As decided by DUGC	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Note: Honors and Minor are additional academic provisions and are not counted as separate components within the six regular B.Tech. course components.

EC200N ANALOG COMMUNICATION (2-1-0) 3

Overview of the Fourier Series and Fourier Transform, Rayleigh Energy Theorem, Inverse relation between time and frequency, transmission of signals through linear systems. Hilbert Transform and the notion of pre-envelope, Canonical representation of band-pass signals, phase and group delay, various types of amplitude modulation, their virtues, and limitations. Amplitude modulation (AM), Frequency translation, baseband signal recovery, spectrum of an AM signal, types of modulators, SSB and VSB modulation and their applications, Simple circuits/ SDR implementations for AM signal generation and demodulation, Superheterodyne receiver. Angle modulation, phase and Frequency Modulation (FM), Spectrum of an FM signal with sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, Phasor diagram for FM signals, Spectrum of Wideband FM, Simple circuits/ SDR implementations for FM generation and demodulation. Stereophonic FM broadcasting, Simple circuits/ SDR implementations for FM signal generation and demodulation, Phase locked loops and their applications, Introduction to random processes. Review of probability theory, random variables, statistical averages, transformation of random variables, random processes, stationarity, Mean, Correlation and Covariance functions, Ergodicity. Transmission of a random process through a linear filter, power spectral density, Gaussian process, Noise, Mathematical representation of noise, Spectral components of noise, representation of noise using orthonormal components, irrelevant noise components. Review of FM demodulator principles, calculation of output signal and noise powers, pre-emphasis and deemphasis, commercial standards for preemphasis and deemphasis. Resistor noise, networks with reactive elements, available power, noise temperature, noise bandwidth, noise temperature, noise figure, receiver system example, antenna temperature and its significance. The sampling process and the sampling theorem, Pulse amplitude modulation, Time division multiplexing, Pulse position modulation, Bandwidth-Noise trade-off. Pulse Code modulation (PCM), Noise considerations in PCM, Delta modulation, Adaptive delta modulation. Matched filter, error rate due to noise, Inter-symbol interference, Nyquist's criterion for distortion less baseband binary transmission, Correlative coding, Introduction to tapped delay line equalization.

S. Haykin, "Communication Systems", Wiley India Edition, 2009.
H. Taub, D.L. Schilling and G. Saha, Principles of Communication Systems, 3rd edition, Tata McGraw Hill, 2008
B. P. Lathi, Z. Ding "Modern Digital and Analog Communication Systems", Oxford University Press, 2010.
J. M. Wozencraft, I. M. Jacobs, Principles of Communication Engineering, Wavelend Press Inc. 1965.
NPTEL course on Analog Communications by Prof. Goutham Das, IIT Kgp.
Swayam course of Fundamentals of Communication system and its applications

EC201N DIGITAL SYSTEM DESIGN (2-1-0) 3

Logic gates, Boolean algebra, Positional number systems, representation of negative numbers, binary arithmetic code, Switching algebras, Introduction to HDL (Verilog), Behavioral, structural and dataflow Modelling and simulation.

Combinational circuit analysis, Minimization techniques – K map, Combinational circuit synthesis using gates. Combinational circuit synthesis using MSI ICs. Modelling Combinational circuits using Verilog HDL. Latches and flip flops, Setup and Hold time, Clock period and frequency, Analysis of sequential circuits. Synchronous sequential circuit synthesis using flipflops and MSI ICs. Synchronous sequential circuit Modelling with HDL Finite state machine (FSM) synthesis using flipflops. Finite state machine (FSM) Modelling with HDL. ASM charts, state minimization, state assignment. Design case studies (ex. processor data path and control path)

Mano, M. Morris R., and Michael D. Ciletti. Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog. 6th ed., Pearson Education, 2018
Brown, Stephen D., and Zvonko G. Vranesic. Fundamentals of Digital Logic with Verilog Design. 4th ed., 2025
David A. Patterson; John L. Hennessy, Computer Organization and Design RISC-V Edition, 2nd ed., Morgan Kaufmann, 2021
nptel.ac.in/courses/117106114

EC202N CIRCUITS, SYSTEMS AND SIGNALS (2-1-0) 3

Introduction to signals and types of signals, Basic signals, operations, and properties, Systems and their properties.

Electric Circuit Analysis: Circuit concept, circuit elements, independent and dependent sources, network reduction techniques, network equations, node voltage and mesh current analysis, Network Theorems-Super position theorem, Norton, Thevenin, Maximum power transfer theorem. Time domain analysis of linear signals and systems: Impulse response, convolution, correlation, First order systems - Analysis of RL and RC circuits, representation of systems using differential equations, solution of differential equations, Transient and steady state response, time constant, initial conditions, Second order systems - RLC circuits, characteristic equation, damping, natural frequency, time domain specifications of systems, State variable description. Transform domain analysis of systems: Laplace Transform: Definition and properties, inverse transforms, partial fraction expansion. Transform domain analysis of systems, equivalent sources for initial conditions, transform circuits, Impedance functions and Network Theorems, transfer function stability. Frequency domain analysis of continuous time signals and systems: Steady state response of R, L, C elements to sinusoidal excitation, series and parallel resonance, frequency domain specifications. Periodic signals, Fourier series representation, properties of Fourier series. Non-periodic signals, Fourier transform, properties of Fourier transforms and applications to systems, Parsevaal's Theorem.

W. Nillson and SA Riedel, Electric Circuits, PHI, 2000
Oppenheim, A. V., Willsky, A. S., & Nawab, S. H. (2015). Signals and Systems (2nd ed.,), Pearson
B. P., Lathi. Signals, Systems and Communication. BS Publications, Second edition, 2001.
William H Hayt, et al. Engineering Circuit Analysis. McGraw Hill India, Ninth edition, 2020.

EC203N PROBABILITY AND RANDOM PROCESSES (2-1-0) 3

Review of elementary probability, Formal definition of a probability space, axioms, examples, properties, Conditional Probability, Independence and conditional independence, independence of more than two events, Partition formula, Discrete random variables, definition, examples - Bernoulli, Binomial, Poisson, Uniform and Geometric random variables, distributions and properties, Expectation of a random variable, mean, variance, moments examples - Bernoulli, Binomial, Poisson, Uniform and Geometric Random Variables, Continuous Random Variable, definition probability distribution function - Uniform, Exponential, Gaussian Random variables, Mean and Variance, moments, moment generating functions, Joint distribution of random variables, Conditioning of random variables, conditioning on events, other random variables, conditional distributions, examples, Random vectors, multi dimensional probability distribution, moments, mean vector, covariance matrix, Random sequences, Bernoulli process, properties, Time of Kth arrival, Merging and splitting of Bernoulli processes, examples, Poisson Process, Definition, Applications, Number of Arrivals and Poisson PMF, Mean and Variance, Time of Kth Arrival, examples, Sum of independent poisson random variables, Merging/Splitting a Poisson process, Different sampling methods, Poisson versus normal approximations, Introduction to Markov Processes, Discrete time finite state Markov chains, N step transition probabilities, Markov Process - Recurrent and Transient states, steady state probabilities, Birth-death processes.

Introduction to Probability, 2nd ed, Dimitri P. Bertsekas and John N. Tsitsiklis, MIT, 2008
Probability, Statistics, and Random Processes for Engineers, "Henry Stark and John W. Woods", Pearson Education, 2012 https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/ https://onlinecourses.nptel.ac.in/noc26_ma23/preview

EC204N ANALOG COMMUNICATION LAB (0-0-3) 1.5

Verification of sampling theorem. AM generation and detection with AGC. FM generation and demodulation. DSBSC modulation and demodulation using multiplier IC. Characterization of tuned amplifier circuit. Generation and detection of PAM, PWM and PPM. Performance analysis of analog communication systems in the presence of noise using MATLAB. Study of AM systems using Simulink. RF Mixer circuit. Characteristics

of pre-emphasis and de-emphasis circuits. Frequency division multiplexing. Analysis of AM and FM signals with spectrum analyzer.

M.F. Mesiya, "Contemporary Communication Systems", First Edition, McGraw-Hill India, 2014
Proakis and Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson Education, 2014.
Communication lab manual

EC205N DIGITAL SYSTEM DESIGN LAB (0-0-3) 1.5

Familiarization of software and trainer kits, and HDL. Experiments implementing simple combinational circuits using logic gates. Implementation of comparator and code converter circuits. Implementation of multiplexer, demultiplexers, encoders & decoder circuits. Design and implementation of Arithmetic Building Blocks for Digital Systems. Implementation of various flip-flops circuits. Implementation of register & counters. Implementation of sequential circuits. Design and implementation of control logic FSMs. RTL Case study. Term project involving complete digital system design and implementation on a suitable FPGA board.

Mano, M. Morris R., and Michael D. Ciletti. Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog. 6th ed., Pearson Education, 2018
Brown, Stephen D., and Zvonko G. Vranesic. Fundamentals of Digital Logic with Verilog Design. 4th ed., 2025
https://nptel.ac.in/courses/106105165

EC250N ELECTROMAGNETIC WAVES AND TRANSMISSION LINES (2-1-0) 3

Course introduction, overview, and motivation. Review of static electric and magnetic fields and their properties. Coordinate systems, Vector operators. Maxwell's equations. Electric charges and currents, Maxwell's equations in differential and integral form, Material media, Boundary conditions at the interface between material media,

The Maxwell equations in steady state, Power, and the Poynting theorem, Propagation of plane electromagnetic waves- The wave equations, Introduction to plane waves, Plane waves in ideal dielectric media, Plane waves in media with losses, Wave Propagation in Linear/Homogeneous/Isotropic Media and plasmas. Wave Propagation in Conducting Media, Dispersion Phenomena in Linear/Homogeneous/Isotropic Media. Plane wave polarization, Reflection and transmission of plane waves at the interface between material media. Electromagnetic Fields Associated with a Circular Parallel-Plate Capacitor and Waveguide. Waveguides and Guided EM Waves, Electromagnetic Radiation, Hertizian Dipole, Electric Dipole Radiation, Antenna Parameters-gain, directivity, radiation pattern, and bandwidth & returnloss

Antenna Arrays- broadside and end fire arrays, Planar arrays, Introduction to transmission lines, Distributed transmission-line circuit model, General transmission-line equations in time, Wave characteristics on an infinite transmission line, Time-harmonic transmission-line equations, Propagation constant. Wave Characteristics on Finite Transmission Lines and Input Impedance.

Ulaby, F. T., & Ravaioli, U. (2020). Fundamentals of Applied Electromagnetics. (8 ed.) Pearson
D.J. Griffiths, Introduction to Electrodynamics, 3a ed., Prentice-Hall, 1999
C.A. Balanis, Advanced Engineering Electromagnetics, Wiley, 1989
Matthew N.O. Sadiku, Principles of Electromagnetics, 6th Edition, OUP, 2015.
https://nptel.ac.in/courses/117101056
https://nptel.ac.in/courses/108106157

EC251N ANALOG ELECTRONICS (2-1-0) 3

Introduction to Linear/Non-linear Circuits, Amplifier fundamentals, Controlled Sources.Two-port Networks, Feedback Concepts: Feedback topologies. Positive and Negative feedback, Effect of Negative feedback on basic amplifiers, Instability in amplifiers, Barkhausen condition for Oscillations. Opamp ideal characteristics, Non idealities of Opamps and their effects: Finite gain, Finite bandwidth, Offset voltages and currents. Non-

inverting and Inverting Amplifiers, Voltage Follower, Summing Amplifiers. Difference amplifiers, Opamp differentiator, Opamp integrator, All-pass filter (Active phase shifters), Passive Filters - First and Second order filter transfer functions (low pass, high pass, band pass and band reject), Butterworth response. Emulation of inductor using gyrators, Transconductor-Capacitor Filters,

Active-RC Filters, Sallen-Key biquadratic low and high-pass filters. Tow-Thomas biquad, Realization of higher order filters. Non-linear Applications of Opamps: Comparators, Schmitt trigger (Inverting & Non-Inverting). Astable Multivibrator, Triangular wave generator, Oscillators, RC Phase shift, Wienbridge, LC and Crystal oscillators, Precision rectifiers

Sedra and Smith, "Microelectronics Circuits", Oxford Univ. Press, 2013.
Behzad Razavi, Fundamentals of Microelectronics, Third edition, Wiley, 2021
Sergio Franco, "Design with OPAMPS and Linear Integrated circuits", McGraw Hill, 2017
https://nptel.ac.in/courses/108101094
https://onlinecourses.nptel.ac.in/noc24_ee81/preview
https://nptel.ac.in/courses/108102112

EC252N DIGITAL SIGNAL PROCESSING (2-1-0) 3

Introduction to DSP; Basic discrete-time signals, operations, and properties, introduction to sampling, aliasing Discrete-time systems - properties, linear-time invariant systems, impulse response, convolution, correlation, causality and stability; Representation of LTI systems - difference equations, Z Transform: Definition and properties, ROC, inverse Z transform, transfer function, poles and zeros, relate system behaviour in time and frequency domains to pole-zero plot, Application of Z transforms to discrete-time systems, Representation of systems – signal flow graph, realisation of a Z-domain transfer function, Fourier series & Fourier transform, Discrete Fourier series (DFS), Properties of DFS, Relation between continuous and discrete time spectra, aliasing, reconstruction of continuous-time signal from samples, Discrete-time Fourier transform (DTFT), properties and applications of DTFT, Relationship between the three domains – h(n), H(z), H(), Sampling in frequency domain, Discrete Fourier Transform (DFT), DFT properties, linear convolution using DFT, Circular convolution, use of DFT in linear filtering, filtering of long data sequences, Efficient computation of DFT, Fast Fourier transform (FFT) algorithms – DIT, DIF, Characteristics of digital filters, Types, Filter Structures, design from pole-zero map, LPF, HPF and BPF, Digital resonators, Notch, and All-pass filters. FIR filter design: window method, frequency sampling method, optimal filter design, IIR filter design: H(s) H(z), Filter design using Butterworth, Chebyshev & Elliptic approximations, Direct design of IIR filters, Finite word length effects, Real-time implementation of SP algorithms - options, Application of DSP to Speech, Audio, Image, Video and Biomedical signal processing.

Proakis J. G. and D. G. Manolakis, Introduction to Digital Signal Processing (5e), Pearson Education, 2022
Oppenheim A. V. and R. W. Schafer, Discrete time signal processing (3e), Pearson, 2021.
P. P. Vaidyanathan, Signals, Systems and Signal Processing, CUP, 2024
Ashok Ambardar, Digital Signal Processing A Modern Introduction, Thomson, 2007
https://nptel.ac.in/courses/108101174
https://nptel.ac.in/courses/117102060
https://nptel.ac.in/courses/117105134
https://nptel.ac.in/courses/108105055
https://nptel.ac.in/courses/108106151

EC253N MICROPROCESSOR BASED SYSTEMS (2-1-0) 3

Introduction to Microprocessors: Introduction to computer organization, CISC, RISC, Concept of pipelining, Evolution of Microprocessors. Introduction to stored program Concept: Instruction Set Architecture: Instruction formats and addressing modes. Introduction to ARM processor: ARM overview, Programming Model, Processor and memory organization, concept of stack. ARM Instruction set: Data-processing Instructions, Data

Transfer Instructions, Control Instructions, Additional special instructions, Addressing modes & Instruction Encoding

ARM Implementation, organization and execution:The data flow model for Data-processing Instructions, Data Transfer Instructions, Control Instructions , ARM Instruction Datapath Timing, The 3-stage pipe line organization, pipeline hazards, PC behaviour Introduction to Thumb instruction set (TIS): Need for TIS, Thumb implementation and its encoding, ARM Processor Modes and Exceptions: Processor Modes in Detail, Exception Types, vector table, exception Handling, Priority, ARM interfacing to peripherals: Interfacing ARM to GPIO, UART, DAC

Assembly Language Programming ARM Cortex-M3" by Vincent Mahout, ISTE Ltd and John Wiley & Sons, Inc
https://www.arm.com/products/silicon-ip-cpu/cortex-m/cortex-m3

EC254N MICROPROCESSOR LAB (0-0-2) 1

Introduction: Introduction to ARM instructions and assembly level programming. Familiarization with software development platforms. Assembly Language Programming. Simple Assembly Language Programs involving arithmetic and logical operations. Array and matrix manipulations: sort, search delete/ insert, dot product, matrix addition and multiplication. Assembly programming involving strings. High precision arithmetic: long-long addition/ subtraction, multiplication, Division. Evaluation Boards: Downloading and Verification on the target board. Interfacing various peripherals in Assembly Language Programing -GPIO, UART.Apply high-level programming (C) to implement algorithms on microprocessors. Interface HLL code with peripherals to perform embedded applications. Term project: Implement and integrate a practical embedded system application.

"Assembly Language Programming ARM Cortex-M3" by Vincent Mahout, ISTE Ltd and John Wiley & Sons, Inc
https://www.arm.com/products/silicon-ip-cpu/cortex-m/cortex-m3
J.R. Gibson, "ARM Assembly Language-An Introduction", CENGAGE Learning.

EC255N DIGITAL SIGNAL PROCESSING LAB (0-0-2) 1

Review of python programming, Numpy, Scipy, Pandas Library. Simulation of Basic discrete-time signals, operations, and properties, introduction to sampling, aliasing. Implementation of Discrete-time systems - properties, linear-time invariant systems, impulse response, convolution, correlation, causality and stability; Representation of LTI systems - difference equations. Implementation of Z Transform: Definition and properties, ROC, inverse Z transform, transfer function, poles and zeros, relate system behaviour in time and frequency domains to pole-zero plot. Implementation of Continuous Fourier series & Fourier transform, Discrete Fourier series (DFS), Properties of DFS, Relation between continuous and discrete time spectra. implementation and analysis Discrete-time Fourier transform (DTFT), Sampling in frequency domain, implementation of Discrete Fourier Transform (DFT), DFT properties, linear convolution using DFT, use of DFT in linear filtering, filtering of long data sequences, Implementation and analysis of radix -2 Fast Fourier transform (FFT) algorithms – DIT, DIF Implementation and analysis of digital FIR filters, Types,.Implementation and analysis of digital IIR filters, Implementation and analysis of discrete time signals and systems using DSP Board.

Programming for everybody, Online course https://www.coursera.org/learn/python
Numpy Tutorial https://docs.scipy.org/doc/numpy-dev/user/quickstart.html
Proakis J. G. and D. G. Manolakis, Introduction to Digital Signal Processing (5e), Pearson Education, 2022
Oppenheim A. V. and R. W. Schafer, Discrete time signal processing (3e), Pearson, 2021.
Ashok Ambardar, Digital Signal Processing A Modern Introduction, Thomson, 2007

EC256N ANALOG ELECTRONICS LAB (0-0-3) 1.5

Review of analog components, demo of lab equipments (CRO, function generator, multimeter, DC power supply, transformer). Design and implement Half wave and Full wave rectifier along with capacitor filter and voltage regulator. Design and implement Bridge rectifier with capacitor filter and voltage regulator. Design and implement Op-amp based non-inverting buffer, inverting and non-inverting amplifier. Design and implement inverting and non-inverting summing amplifier with and without zener diode. Design and implement voltage controlled current source, current to voltage converter, and push pull amplifier. Design and implement self biasing circuit with and without bypass capacitor, cascade amplifier. Design and implement op-amp based current and difference amplifier, integrator and differentiator. Design and implement Wein bridge oscillator, phase shift oscillator using BJT and op-amp equivalent. Design and implement Colpitt's oscillator using BJT and op-amp and crystal oscillator. Design and implement filters - All pass phase shift, KRC- Low pass filter, High pass filter. Design and implement filters - Band pass filter

Sedra and Smith, "Microelectronics Circuits", Oxford Univ. Press, 2013.
Behzad Razavi, Fundamentals of Microelectronics, Third edition, Wiley, 2021
Sergio Franco, "Design with OPAMPS and Linear Integrated circuits", McGraw Hill, 2017

EC300N CONTROL SYSTEMS AND AUTOMATION (2-1-0) 3

Introduction, motivation, history, representation of systems, physics principles, equivalence between mechanical, electrical, pneumatic, etc, Open loop and closed loop systems, feedback systems, types; linear and nonlinear, Time and frequency domain analysis, Fourier and Laplace transform, Transfer function, Block diagram representation, block diagram algebra, signal flow graphs, simplification methods, Poles, zeros, first and second order systems, response of systems to standard test inputs; impulse, step, sinusoidal etc, Transient and steady state response, stability criteria, BIBO stability, Time domain analysis: Transient & Steady-State Response, Performance, pecifications (Rise Time, Overshoot, Settling Time), Error Analysis & Constants, Stability using Routh-Hurwitz Criterion, Lyapunov Stability, Frequency Domain Analysis: Frequency Response (Bode Plot, Polar Plot, Nyquist Plot), Performance Specs (Gain Margin, Phase Margin), Stability using Nyquist Stability Criterion, Root Locus Techniques, Controller Design: PID Controllers (Proportional, Integral, Derivative), Root Locus Design (Adding Poles/Zeros), Frequency Domain Compensation (Lead, Lag, Lag-Lead), State-Space Methods: State-Space Representation (Modelling, Solution), Controllability & Observability, Pole Placement, Luenberger Observer, LQR, Digital Control: Z-Transforms, Discrete State-Space, Digital Controller Design. Design and simulation using appropriate tools like MATLAB/Simulink, Python etc

Ogata, Discrete - Time Control Systems, PHI 2005.
Modern Control Engineering - by Katsuhiko Ogata - Prentice Hall of India Pvt. Ltd., edition, 2010.
Gene Franklin, David Powell, Abbas Emami-Naeini, Feedback Control of Dynamic Systems, Pearson Education, 2019.
Automatic Control Systems- by B. C. Kuo and Farid Golnaraghi - John wiley and son's, 8th edition, 2003.
https://onlinecourses.nptel.ac.in/noc20_ee90/preview
https://onlinecourses.nptel.ac.in/noc24_ee62/preview

EC301N VLSI DESIGN (2-1-0) 3

MOS theory – input, output characteristics of NMOS & PMOS, second order effects. NMOS inverter with resistive load, enhancement NMOS load, depletion NMOS load, Pseudo-NMOS load. CMOS inverter, MOSFET Modelling – GATE capacitances, SPICE parameters. CMOS fabrication process overview of N-well, twin-well, silicon on insulator processing technology. Spice simulation of logic gates and analysis, Layout & design rules, Latch-up, NMOS, CMOS logic gates – combinational logic circuits.. CMOS sequential logic circuits. Pass transistor logic & Transmission gates. Introduction to CAD tools – (Demo on Magic), Extraction, Circuit elements resistance, capacitance estimation. Switching characteristics. Delay Models, power dissipation, Interconnect delay, Timing analysis, charge sharing, scaling of MOS transistor dimensions,

Pseudo-NMOS logic, Dynamic logic, Domino Logic, Clocked systems, Latches, Flipflops, Memory Architecture, ROMs, SRAM, DRAM memory elements, address decoders., System level perspective, switch level simulation (IRSIM), LVS using Netgen

Digital Integrated Circuits: A design perspective, (2nd Edition), Jan M Rabaey, A Chandrakasan, B Nikolic, Pearson Education 2002.
CMOS Digital Integrated Circuits (3rd ed.), Kang & Leblebici, Tata McGraw – Hill.
Principles of CMOS VLSI Design - A system perspective, (2nd Edition) Neil H.E Weste and Kamran Eshraghian, Pearson Education

EC302N DIGITAL COMMUNICATION (2-1-0) 3

Overview of Digital Communication Systems, Fundamental tradeoffs in Communication Systems, Geometric representation of Signal waveforms, Signals and Noise. Binary modulation schemes, Optimum receiver for binary modulated signals in AWGN. M-ary Digital modulation, Optimum receiver for M-ary signals in AWGN, Union bound on the Probability of error. Generation, detection and Probability of Error analysis for M-ary PAM and M-ary ASK systems. Generation, detection and Probability of Error analysis for M-ary PSK and DPSK systems.

Geometric representation of QAM Signals, Demodulation and Detection of QAM Signals, Probability of Error for QAM. PLL, Costas loop, Carrier phase estimation for PAM, PSK and QAM. Symbol synchronization, Early-Late gate, MMSE and ML methods. Modulation, detection and performance analysis of M-ary FSK and CPFSK signals.

Digital transmission through bandlimited AWGN channels, Design and performance analysis of Channel Equalizers.

Introduction to Information Theory, Source coding theorem and algorithms, Channel capacity, Modelling of communication channels. Introduction to channel fading and diversity combining techniques. Introduction to Spread Spectrum Communication Systems. Introduction to OFDM systems.

Proakis and Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson Education, 2014.
M.F. Mesiya, "Contemporary Communication Systems", McGraw-Hill Education, 2017.
Michael Rice, "Digital Communications: A Discrete Time Approach", Pearson Education, 2011.
Mehmet Safak, "Digital Communications", John Wiley & Sons, 2017.
Richard W. Middlested, "Digital Communications with Emphasis on Data Modems: Theory, Analysis, Design, Simulation, Testing, and Applications", John Wiley & Sons, 2017.
https://nptel.ac.in/courses/117101051

EC303N FOUNDATIONS OF MACHINE LEARNING (2-1-0) 3

Decision theory, continuous features, discriminant features and surfaces, Models with gaussian density, Parameter estimation, ML/Bayesian estimation, Examples, Linear regression of one variable, cost function and solution, gradient descent, Multivariate regression, non linear features, underfitting, overfitting, regularization, Logistic regression, cost function, Regularization, Extension of linear models to non linear models, single layer neural network, artificial neural networks, loss functions, back propagation, examples of regression and classification tasks. Alternate Classification systems - Support vector machines, Decision trees, Random forests and Gradient Boosting, Deep learning, vanishing gradient descent problem – solutions, Special architectures, convolutional and recurrent neural networks, Imagenet data, Unsupervised learning algorithms - K means clustering, applications, imensionality reduction, Recommender systems, NN embeddings as features, Introduction to generative models - Autoencoder, Variational Autoencoders, Generative Adversarial Networks (GAN)

Bishop, Christopher M., "Pattern Recognition and Machine Learning", Springer 2006
Duda, Richard O., Peter E. Hart and David G. Stork., "Pattern Classification", John Wiley & Sons, 2012

https://www.deeplearningbook.org/ *https://www.coursera.org/learn/machine-learning*
https://www.deeplearning.ai/deep-learning-specialization/
https://onlinecourses.nptel.ac.in/noc26_cs76/preview

EC304N RF COMPONENTS AND CIRCUITS (2-1-0) 3

Review of electromagnetic theory and transmission line fundamentals, Introduction to printed transmission lines. Introduction to Smith chart, Transmission Line Solutions Using the Smith Chart. Wireless System Architecture and Friis Transmission Equation. Radio Wave Propagation Mechanisms and Channel Impairments. High-frequency effects in RF components and circuits. S-parameters and RF network measurement techniques. Impedance matching methods and bandwidth optimization criteria. RF passive component characterization: T-junction divider and directional coupler. Microwave resonators - line resonator, Q-Factor, excitation. Ferrite devices: isolators, circulators, and phase shifters. Noise and nonlinearity in RF systems. RF Mixers and Amplifiers. Introduction to microwave systems and radar fundamentals.

David M. Pozar, Microwave Engineering, An Indian Adaptation: Theory and Techniques, Wiley, 2022.
Charles. E. Free, Colin S. Aitchison, RF and Microwave Circuit Design-Theory and Applications, Wiley, 2022.
Michael Steer, Microwave and RF Design: A Systems Approach, SciTech Publishing, 2010.
Devendra K. Misra, Radio-Frequency and Microwave Communication Circuits: Analysis and Design, John Wiley & Sons, 2012.
NPTEL: Microwave Engineering: https://nptel.ac.in/courses/108101112
https://nptel.ac.in/courses/108103141

EC305N VLSI DESIGN LAB (0-0-2) 1

Spice analysis of MOSFET input, output characteristics with parametric sweeps. Spice analysis of inverter (Ratioed logic families). Spice analysis of CMOS gates. Layout of CMOS gates, extraction and Spice analysis of extracted Layout of CMOS gates. Term Project (involves layout, LVS, switch level simulation.

Digital Integrated Circuits: A design perspective, (2nd Edition), Jan M Rabaey, A Chandrakasan, B Nikolic, Pearson Education 2002.
CMOS Digital Integrated Circuits (3rd ed.), Kang & Leblebici, Tata McGraw – Hill.
Principles of CMOS VLSI Design - A system perspective, (2nd Edition) Neil H.E Weste and Kamran Eshraghian, Pearson Education

EC306N DIGITAL COMMUNICATION LAB (0-0-3) 1.5

Design and testing of 4-ary PAM, Design and testing of BPSK Modem, Design and testing of BFSK Modem, Design and testing of QPSK Modulator, PLL and Frequency Synthesizers, Montecarlo Simulation of Performance of Wireless Communication Systems, Implementation of FM Transceiver using SDR, Implementation of QAM Transceiver systems using SDR, Design and testing of real time communication systems using Microcontroller Boards, Measurement of frequency, guided wavelength, power, attenuation and VSWR, Radiation pattern and Gain measurement of waveguide Horn antenna, Characterization of passive microwave devices, Optical Fiber Communication

M.F. Mesiya, "Contemporary Communication Systems", First Edition, McGraw-Hill India, 2014.
Ananjan Basu, "An Introduction to Microwave Measurements", First Edition, CRC Press, 2017.
Robert W. Stewart, K W Barlee, and D S W Atkinson, "Software Defined Radio using MATLAB & Simulink and the RTL-SDR", Strathclyde Academic Media, 2015.
Rongqing Hui and Maurice O'Sullivan, "Fiber-Optic Measurement Techniques", 2nd Edition, Academic Press, 2022.
Analog and Digital IC Handbooks
Reports, Guides and White Papers on Latest Communication Standards

List of Electives

EC352N COMPUTER ORGANIZATION AND ARCHITECTURE (3-0-0) 3

Digital Computer Organization, CPU Design, CPU Design Timing and Control, Micro programmed Control, Pipeline Concept, Memory Organization, Cache Memory Architecture, RAM Architecture SRAM and DRAM Architectures, Secondary Storage Organization.

John Hayes, Computer Architecture and Organization, 3rd Ed. McGraw Hill 2017.
John Hennessy and David Patterson, Computer Architecture - A Quantitative Approach 6th Edition, Morgan Koufmann, 2017
John Hennessy and David Patterson, Computer Architecture - A Quantitative Approach 5th Edition, Morgan Koufmann, 2011

EC353N COMPUTER ARITHMETIC (3-0-0) 3

Number Representation: Numbers and Arithmetic, Representing Signed Number, Redundant Number Systems,

Residue Number Systems, Double base number systems, Addition/Subtraction: Basic Addition and Counting, Carry- Look ahead Adder, Variations in Fast Adders, Multi-Operand Addition, Multiplication: Basic Multiplication

Schemes, High-Radix Multipliers, Tree and Array Multipliers, Variations in Multipliers, Division: Basic Division

Schemes, High-Radix Dividers, Variations in Dividers, Division by Convergence, Real Arithmetic: Representing the Real Numbers, Floating-Point Arithmetic, Arithmetic Errors and Error Control, Precise and Certifiable Arithmetic, Function Evaluation: Square-Rooting Methods, The CORDIC Algorithms, Variations in Function Evaluation, Arithmetic by Table Lookup, Implementation Topics: High Throughput Arithmetic, Low-Power Arithmetic, Fault-Tolerant Arithmetic, Past, Present, and Future

I. Koren, Computer Arithmetic Algorithms, 2nd Edition, A. K. Peters (part of CRC Press), 2002
M. Ercegovac and T. Lang, Digital Arithmetic, Morgan Kaufman, 2003.
B. Parhami, Computer Arithmetic: Algorithms and Hardware Design, Oxford University Press 2000.
Literature from the web including the proceedings of IEEE Intl. Conference on Computer Arithmetic.

EC354N EMBEDDED SYSTEM DESIGN (2-0-2) 3

Introduction: Overview of embedded systems, embedded system design challenges, common design metrics and optimizing. Survey of different embedded system design technologies & trade-offs. Embedded microcontroller cores, embedded memories, Examples of embedded systems. Architecture for embedded system, High performance processors – strong ARM processors, programming, interrupt structure, I/O architecture, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, Digital signal processing, Subsystem interfacing, interfacing with external systems. Software aspects of embedded systems: real time programming languages and operating systems for embedded systems – RTOS requirements, kernel types, scheduling, context switching, latency, inter-task communication and synchronization, Case studies.

Jack Ganssle, The Art of Designing Embedded Systems, Elsevier, 1999.
J.W. Valvano, Embedded Microcomputer System: Real Time Interfacing, Brooks/Cole, 2000. David Simon, An Embedded Software Primer, Addison Wesley, 2000.
H. Kopetz, Real-time Systems, Kluwer, 1997
R. Gupta, Co-synthesis of Hardware and Software for Embedded Systems, Kluwer 1995. Gomaa, Software Design Methods for Concurrent and Real-time Systems, Addison-Wesley, 1993.
Steve Furber, “ARM System Architecture”, Edison Wesley Longman, 1996.

Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier, 2004

EC355N FPGA BASED SYSTEM DESIGN (2-0-2) 3

Digital system design options and trade-offs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral Modelling and simulation, Hardware description languages, combinational and sequential design, state machine design, synthesis issues, test benches. Overview of FPGA architectures and technologies: FPGA Architectural options, granularity of function and wiring resources, coarse vs fine grained, vendor specific issues (emphasis on Xilinx and Altera), Logic block architecture: FPGA logic cells, timing models, power dissipation I/O block architecture: Input and Output cell characteristics, clock input, Timing, Power dissipation, Programmable interconnect - Partitioning and Placement, Routing resources, delays; Applications - Embedded system design using FPGAs, DSP using FPGAs, Dynamic architecture using FPGAs, reconfigurable systems, application case studies. Simulation / implementation exercises of combinational, sequential and DSP kernels on Xilinx / Altera boards.

M.J.S. Smith, Application Specific Integrated Circuits, Pearson, 2000 Peter Ashenden, Digital Design using VHDL, Elsevier, 2007 Peter Ashenden, Digital Design using Verilog, Elsevier, 2007
Clive Maxfield, The Design Warriors's Guide to FPGAs, Elsevier, 2004

EC356N ANALOG INTEGRATED CIRCUITS (3-0-0) 3

MOSFET - Review of current equation, regions of operation, small signal model. Current mirrors, Single-ended amplifiers: CS amplifier CG and CD amplifiers, CMOS differential amplifiers: DC analysis and small signal analysis of differential amplifier with Resistive load, current mirror load and current source load, Input common-mode range and Common -mode feedback circuits. OTAs vs Opamps. Slew rate, CMRR, PSRR. Two stage amplifiers, Compensation in amplifiers (Dominant pole compensation).

Behzad Razavi, Fundamentals of Microelectronics, Second edition, Wiley, 2013 Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004

EC357N DATA STRUCTURES AND ALGORITHMS (2-0-2) 3

Algorithm analysis, Asymptotic notations. Divide and Conquer algorithms, Analysis of divide and conquer algorithms, master method, examples - merge sort, quick sort, binary search, Data structures, Linked list, stacks and queues, insertion/deletion and analysis, Binary search trees Hash Tables – hash function and properties, collision handling, bloom filters, Greedy algorithms and Dynamic programming examples. Graph traversal, DFS, BFS, shortest path algorithms Dijkstra's and Bellman Ford algorithm, Minimum spanning trees, min cut.

Sartaj Sahni, Data Structures, Algorithms and Applications in C++, Universities Press, 2005 A.V. Aho, J.E. Hopcroft and J. D. Ullman, Data structures and Algorithms, Pearson, 2004. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, Introduction to Algorithms, PHI, 2004. Mark Allen Weiss, Algorithms, Data structures and problem solving with C++, Pearson, 2002.

EC358N SPEECH AND AUDIO PROCESSING (3-0-0) 3

Speech Production–human speech production mechanism, acoustic theory of speech production, digital models for speech production. Speech perception– human hearing, auditory psychophysics, JND, pitch perception, auditory masking, models for speech perception. Speech Analysis–Time and frequency domain analysis of speech, speech parameter estimation, Linear prediction. Speech compression –quality measures, waveform coding, source coders, Speech compression standards for personal communication systems. Audio processing–characteristics of audio signals, sampling, Audio compression techniques, Standards for audio compression in multimedia applications, MPEG audio encoding and decoding, audio databases and applications. Speech synthesis–text to speech synthesis, letter to sound rules, syntactic analysis, timing and

pitch segmental analysis. Speech recognition–Segmental feature extraction, DTW, HMMs, approaches for speaker, speech and language recognition and verification

Douglas O'Shaugnessy, Speech Communication–Human and Machine, IEEE Press, 2000
L R Rabiner, Digital Processing of Speech Signals, Pearson,1978 T.F Quatieri, Discrete-time speech signal processing: Principles and Practise Pearson,2002
Zi Nian Li, Fundamentals of Multimedia, Pearson Education, 2003

EC359N IMAGE AND VIDEO PROCESSING (3-0-0) 3

Digital image fundamentals–image acquisition, representation, visual perception, quality measures, sampling and quantization, basic relationship between pixels, imaging geometry, color spaces, Video spaces, analog and digital video interfaces, video standards. Two dimensional systems – properties, analysis in spatial, frequency and transform domains. Image transforms - DFT, DCT, Sine, Hadamard, Haar, Slant, KL transform, Wavelet transform. Image enhancement–point processing, spatial filtering, Image restoration–inverse filtering, de-blurring Video processing– display enhancement, video mixing, video scaling, scan rate conversion, Image compression–lossless and lossy compression techniques, standards for image compression-JPEG, JPEG2000. Video compression–motion estimation, intra and interframe prediction, perceptual coding, standards- MPEG, H.264 Image segmentation–feature extraction, region oriented segmentation, descriptors, morphology, Image recognition.

R. C. Gonzalez and R E Woods, Digital Image Processing, Pearson Education, 2002 A K Jain, Fundamentals of Digital Image Processing, Pearson Education,1989 W Pratt, Digital Image Processing, Wiley, 2001
Al Bovik, Handbook of Image and Video, Academic Press, 2000 Keith Jack, Video Demystified, LLH 2001

EC360N NUMERICAL ANALYSIS AND COMPUTING (3-0-0) 3

Preliminaries on numerical analysis, Errors and measuring efficiency, Review of Linear Algebra, Iterative techniques in matrix algebra, elimination method, inverse of a matrix, ill conditioned systems, eigen values, eigen vectors, LU and QR factorization. Solving nonlinear equations, bisection, Newton's method, Muller's method, fixed point interpolation, steepest descent. Interpolation and curve fitting: interpolating polynomials, spline curves, interpolation on a surface, least square approximations. Approximation of functions: Fourier basis and orthogonal polynomials, rational function approximation. Numerical differentiation and integration, solution of ordinary differential equations: Taylor series method, Euler method, Runge-Kutta method. Solution of partial differential equations, finite element methods, optimization. Introduction to quantum computing, quantum mechanics to understand quantum computation, Quantum algorithms.

Francis B. Hildebrand, Introduction to Numerical Analysis, 2nd Ed, Dover.
SD Conte, C de Boor, Elementary numerical analysis: An algorithmic approach, 3rd Ed, Mc Graw Hill, 1981.
R.L. Burden & J.D. Faires, Numerical Analysis, 9th Ed, Brooks/Cole, Cengage Learning, 2011. Phillip Kaye, Raymond Laflamme and Michele Mosca, An Introduction to Quantum Computing, Oxford 2006.

EC361N SATELLITE COMMUNICATIONS (3-0-0) 3

Introduction to satellite Communications, Satellite orbits, Satellite subsystems, The RF link, Link system performance, Transmission impairments, Propagation effects: Modelling and Prediction, Fading effect, Diversity, The composite link, Satellite communications signal processing, Satellite multiple access, The mobile satellite channel, Spectrum management, Interference mitigation, Satellite navigation and GPS, High throughput satellites.

Louis J. Ippolito, "Satellite Communications Systems Engineering", Second Edition, John Wiley, 2017.
Timothy Pratt and Jeremy E. Allnutt, Satellite communications, Third Edition, John Wiley, 2019.

EC362N PRINCIPLES OF MODERN RADAR AND TECHNIQUES (3-0-0) 3

Introduction and Radar Overview, The Radar Range Equation, Radar Search and Overview of Detection in Interference; External Factors: Propagation Effects and Mechanisms, characteristics of Clutter Target Reflectivity, Target Fluctuation Models, Doppler Phenomenology and Data Acquisition Subsystems: Radar Antennas, Radar Transmitters, Radar Receivers, Radar Exciters, and The Radar Signal Processor

Mark A Richards, Principles of modern radar (POMR)-Basic principles (Vol-1), Scitech publishers
R. Skolnik, Modern Radar Systems, 3rd edition, Mc-Graw Hill Publishers

EC363N COMMUNICATION NETWORKS (3-0-0) 3

Switching techniques, Multiplexing and Multiple Access techniques, Packet Switched Networks. OSI and TCP/IP Models, Internet protocols and addressing, networking devices, data links and transmission, LANs and Network of LANS, Wireless Networks and Mobile IP, Routing and internetworking, transport and end to end protocols, congestion control techniques, Application Layer and network management, Network Security. Packet Queues and delays, Little's theorem, Birth and death process, Queuing disciplines, M/M/1 Queues, Burkes and Jackson theorems. Traffic models, ISDN, ATM Networks, Quality of service and resource allocation, VPNs and MPLS, Cellular Telephone and Optical networks, VOIP and Multimedia networking. Mobile Adhoc Networks and Wireless Sensor Networks

Nader F. Mir, Computer and Communication Networks, Pearson Education, 2007
Garcia and Widjaja, Communication Networks, McGraw Hill, 2006
J.F. Hayes, Modelling and analysis of Computer Comm. Networks, Plenum, 1984.
Jean Walrand & Pravin Varaiya, High Performance Communication Networks, Morgan Kaufmann Publishers, 2002

EC364N WIRELESS MOBILE COMMUNICATION (3-0-0) 3

Applications and requirements of wireless services, Propagation mechanisms and channel characterization, Channel models, Equalizers, Diversity, Spread spectrum techniques, OFDM, MIMO, Resource allocation, Principles of cellular networks, Cooperative communications, 4G, Cellular – 3GPP Long-Term Evolution (LTE), 5G Cellular – 3GPP New Radio (NR), Wireless Local Area Networks, PAN and Internet of Things – Bluetooth and Zigbee, Beyond 5G.

Andreas F. Molisch, "Wireless Communications: From Fundamentals to Beyond 5G", Third Edition, John Wiley & Sons, 2022.
Gordon.L. Stuber, Principles of Mobile Communication, Fourth Edition, Springer International, 2018.
Ke-Lin Du, M.N.S. Swamy, "Wireless Communication Systems: From Fundamentals to 6G", Second Edition, Springer International, 2026

EC365N INFORMATION THEORY AND CODING (3-0-0) 3

Communication systems and Information Theory, Measures of Information, Coding for Discrete sources, Discrete memory-less channels and capacity, Noisy channel coding theorem, Techniques for coding and decoding, Waveform channels, Source coding with Fidelity criterion.

Thomas M Cover & Joy A Thomas, Elements of Information Theory, John Wiley,1991 R.G. Gallagher, Information Theory and Reliable Communication, Addison Wesley, 1987. A.J. Viterbi & J.K. Omura, Principles of Digital Communications and Coding, McGraw Hill, 1979.

EC366N ADHOC AND SENSOR NETWORKS (3-0-0) 3

Mobile ad hoc networks and wireless sensor networks concepts and architectures. Routing: proactive routing, Broadcasting and multicasting, TCP over mobile ad hoc networks, Wireless LAN (WiFi) standards, Medium

Access Control Protocol issues power control, spatial reusability, and QoS, Bluetooth, Wireless sensor networks architecture: hardware and software components of a sensor node, OS for WSN, WSN MAC layer strategies; naming and addressing; Clock Synchronization; Node Localization; WSN Routing.

C Sivarama Murthy and B S Manoj, Ad-Hoc Wireless Networks, Architectures and Protocols, PH, 2004.
Labiod.H, Wireless Adhoc and sensor networks, Wiley, 2008.
Li, X, Wireless ad hoc and sensor networks: theory and applications, Cambridge University Press, 2008

EC367N MULTIMEDIA COMMUNICATION TECHNIQUES (3-0-0) 3

Representation of Multimedia Data, Concept of Non-Temporal and Temporal Media, Multimedia Presentations, Synchronization. Compression of Multimedia Data, Basic concepts of Compression, Audio Compression Introduction to Speech and Audio Compression, Multimedia System Design, General Purpose Architecture for Multimedia Processing, Operating System support for Multimedia, Data, Resource Scheduling with real-time considerations, File System, I/O Device, Management, Delivery of Multimedia data, Network and Transport Protocols, QoS issues, RTP and RSVP, Video-conferencing and video-conferencing standards, Overview of Voice over IP, Multimedia Information Management, Multimedia Data base Design, Content Based Information Retrieval, Image Retrieval, Video Retrieval, Overview of MPEG-7.

Ralt Steinmetz and Klara Nahrstedt, Multimedia: Computing, Communication & Applications, Pearson Education Publications, 2004.

EC368N SOFTWARE DEFINED AND COGNITIVE RADIO (3-0-0) 3

Cognitive radio: goals, benefits, definitions, architectures, Spectrum-Licensed, unlicensed, shared unlicensed, opportunistic unlicensed, Current spectral usage and issues, Regulations, regulation changes, Spectral awareness, Spectrum adaptation, Dynamic frequency selection, Spectrum Sharing priority allocation, Adaptive bandwidth control Policies, Adaptation and optimization- link adaptation, incremental redundancy, jointly adaptive source and channel coding, Digital signal processing role in SDR, Cross- layer optimization (adaptation), Current cellular cognitive features-Hand -off, Channel allocation, cellular network design, Link adaptation, incremental redundancy, Interference avoidance, detection, and cancellation, Power control, Femto cells and relation to cognitive radio. 2.5G/3G/4G cognitive features, Multi-carrier system adaptation (OFDM(A) adaptive features), Collaboration and cooperation in wireless devices, networks, and systems Interference awareness, Multi -dimensional channel variation and dispersion - relation with adaptive radio, Applications of CR into public safety and other applications of CR ,Vertical hand-off and network interoperability - network awareness, multi-tier networks, Biologically inspired cognitive features (like Bats, Ants, human being, etc).

Hoseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems," Ser. Signals and Communication Technology, xviii, I. edition, Springer, August 2007 Joseph Mitola, III, "Cognitive Radio Architecture: The Engineering Foundations of Radio XML," John Wiley and Sons Ltd., 2006.
Jeffrey H. Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall PTR, 2002.
Walter H.W. Tuttlebee, "Software Defined Radio: Enabling Technologies," John Wiley and Sons Ltd., 2002.
Markus Dillinger and Kambiz Madani and Nancy Alonistioti, "Software Defined Radio: Architectures, Systems and Functions," John Wiley and Sons Ltd., 2003

EC369N MACHINE LEARNING FOR WIRELESS COMMUNICATION SYSTEMS (3-0-0) 3

Need for machine learning techniques in wireless communication, Introduction to machine learning, Supervised, unsupervised, and reinforcement learning, Gaussian model, HMM, Clustering, Sequence recognition and analysis, Bayesian networks, Factor graphs, Markov chain Monte Carlo (MCMC) methods, Channel modelling and prediction using machine learning algorithms, Deep learning based channel estimation, Spectrum sensing and signal identification in cognitive radios using machine learning, Machine learning techniques for adaptive modulation and coding techniques, CNN based equalizer design, DNN based channel

coding techniques (LDPC and Polar codes), Machine learning algorithms for MIMO communications, Compressive sensing for wireless sensor networks, Reinforcement learning-based channel sharing in wireless vehicular networks.

Ruisi He, and Zhiguo Ding (Editors), "Applications of Machine Learning in Wireless Communications", IET Press, 2019.
Fa-Long Luo (Editor), "Machine Learning for Future Wireless Communications", IEEE Press & Wiley, 2020.
Osvaldo Simeone, "A Brief Introduction to Machine Learning for Engineers", Now Publishers, 2018.
A. C. Faul, "A Concise Introduction to Machine Learning", CRC Press, 2020.

EC370N SPARSE REPRESENTATIONS AND COMPRESSIVE SENSING (3-0-0) 3

Introduction, mathematical preliminaries, Basis and Frames, Low dimensional signal models, Sensing matrices, Signal recovery via l1 minimization, Necessary and sufficient conditions for L0-L1 equivalence. RIP and random matrices. Johnson-Lindenstrauss Lemma, Stable signal recovery and restricted eigen value property. Recovery algorithms and their performance guarantees. Multiple measurement models and Applications.

S. Foucart and H. Rauhut, "A mathematical introduction to compressive sensing," Birkhauser Press, 2013.
M. Elad, "Sparse and Redundant Representations" Springer 2010.
H. Rauhut, "Compressive Sensing and structured random matrices", Radon series, Comp. Applied math. 2011.
Compressive Sensing Resources - http://dsp.rice.edu/cs/

EC371N DEEP REINFORCEMENT LEARNING (3-0-0) 3

Introduction: Course logistics and overview. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.

Markov Decision Process: Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

Prediction and Control by Dynamic Programming: Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.

Monte Carlo Methods for Model Free Prediction and Control: Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.

Temporal difference (TD) Methods: Incremental Monte Carlo Methods for Model Free Prediction, Overview TD (0), TD (1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

Function Approximation Methods: Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD (0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.

Policy Gradients: Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press, 2019.
Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning." Adaptation, learning, and optimization 12 (2012).
Li, Yuxi. "Deep reinforcement learning." arXiv preprint arXiv:1810.06339 (2018). Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep learning." MIT press, 2016. Reinforcement Learning resource: https://web.stanford.edu/class/cs234/modules.html

EC402N VLSI CAD (3-0-0) 3

Introduction to VLSI design automation: VLSI design methodologies, use of VLSI EDA tools, Algorithmic Graph Theory, computational Complexity; Partitioning: KL algorithm, FM algorithm, EIG Algorithm, Simulated Annealing. Floorplanning and placement: Sliced and non-sliced planning, Polish expression, Simulated annealing, partition based placement; ILP & mathematical programming, partition based, force directed, Fast-Place, quadratic placement algorithms. Routing: Global routing, detailed routing, graph models, Line Search, Maze Routing, Channel routing; via minimization, clock and power routing. High Level Synthesis: Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed scheduling, operator binding; Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological vs logical timing analysis, False paths, Arrival time, Required arrival Time, Slacks.Advanced VLSI Design Automation: Physical Synthesis, Optical Proximity correction, Interconnect issues

Naveed Sherwani, Algorithms for VLSI Physical Design Automation, 3rd ed., Kluwer Academic Pub., 1999
Majid Sarrafzadeh and C. K. Wong, An Introduction to VLSI Physical Design, McGraw Hill, 1996.
Sabih H. Gerez, Algorithms for VLSI Design Automation, John Wiley, 1998
Sung Kyu Lim, Practical Problems in VLSI Physical Design Automation, Springer, 2008
Sadiq M. Sait & Habib Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific Publishing, 1999

EC403N MIXED SIGNAL DESIGN (3-0-0) 3

Sample and Hold Circuits: Basic S/H circuit, effect of charge injection, compensating for charge injection, bias dependency, bias independent S/H. D/A Converter – General considerations, Static non-idealities and Dynamic nonidealities; Current-steering DAC – Binary weighted DAC, Thermometer DAC, Design issues, Effect of Mismatches. A/D converter – General considerations, static and dynamic non-idealities. Flash ADC – Basic architecture, Design issues, Comparator and Latch, Effect of non-idealities, Interpolative and Folding architectures. Successive Approximation ADC; Pipeline ADC. Over sampling ADC – Noise shaping, Sigma-Delta modulator.

Behzad Razavi, Design of Analog CMOS Integrated Circuits McGraw-Hill International Edition 2016 David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley, 2002 Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, 2003. Behzad Razavi, Principles of Data Conversion System Design, Wiley-IEEE Press, 1995 Rudy J. van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Springer, 2003

EC404N ADVANCED COMPUTER ARCHITECTURE (3-0-0) 3

Instruction Level Parallelism: Pipelining, Hazards, Instruction Level Parallelism, Branch prediction, Static and Dynamic Scheduling, Speculation, Limits of ILP. Multicore Memory Hierarchy: Cache trade-offs, Basic and Advanced optimizations, Virtual Memory, DRAM optimizations. Multiprocessors: Symmetric and Distributed architectures, Cache coherence protocols - Snoopy and Directory based, ISA support for Synchronization, Memory Consistency Models. Interconnection Networks: Architectures, Topologies, Performance, Routing, Flow control, Future of NoCs.

John Hennessy and David Patterson, Computer Architecture - A Quantitative Approach 6th Edition, Morgan Koufmann, 2017
John Hennessy and David Patterson, Computer Architecture - A Quantitative Approach 5th Edition, Morgan Koufmann, 2011
John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata
McGraw Hill, 2013
D. A. Patterson and J. Hennessy, Computer Organization and Design, Harcourt Asia, 1998. Behrooz Parhami, Computer Arithmetic Algorithms and Hardware Design, Oxford, 2000.

EC405N VLSI TESTING AND TESTABILITY (3-0-0) 3

Overview of testing and verification, Defects and their Modelling as faults at gate level and transistor level. Functional V/s. Structural approach to testing. Complexity of testing problem. Controllability and observability. Generating test for a signal stuck-at-fault in combinational logic. Algebraic algorithms. Test optimization and fault coverage. Logic Level Simulation – Delay Models, Event driven simulation, general fault simulation (serial, parallel, deductive and concurrent). Testing of sequential circuits. Observability through the addition of DFT hardware, Adhoc and structured approaches to DFT – various kinds of scan design. Fault models for PLAs, bridging and delay faults and their tests. Memory testing, testing with random patterns. LFSRs and their use in random test generation and response compression (including MISRs), Built-in self-test.

M. Abramovici, M. A. Breuer, and A. D. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1994. M. L. Bushnel and V. D. Agarwal, Essentials of Testing for Digital, Memory and Mixed – Signal VLSI Circuits, Kluwer Academic Publishers, 2000.
Ajai Jain, Learning Module for the course - VLSI Testing and Testability, IIT, Kanpur, 2001.

EC406N SYNTHESIS AND OPTIMIZATION OF DIGITAL CIRCUITS (3-0-0) 3

Introduction to Computer aided synthesis and optimization. Hardware Modelling. Advanced Boolean Algebra and Applications – Boolean functions, representations, Shannon co-factors, satisfiability and cover, Binary Decision Diagrams, Representing Boolean functions, ROBDD, ITE operator, Variable ordering- choice of variables, application of BDD to synthesize Boolean functions, Two level combinational logic optimization, Multiple level combinational optimization. Sequential logic optimization. Cell Library Binding. Algorithms for Technology mapping – Structural and Boolean matching, Simulation & Static Timing analysis - Event driven simulation – zero delay, unit delay and nominal delay simulation, Timing analysis at the logic level, Delay models, Delay graph, static sensitization, State of the art and future trends: System level synthesis.

Giovanni De Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill, 1994. Srinivas Devadas, Abhijith Ghosh and Kurt Keutzer, Logic Synthesis", Kluwer Academic, 1998.
G. D. Hachtel and F. Somenzi, Logic Synthesis and Verification Algorithms, Kluwer Academic Publishers, 1996. S. Hassoun and T. Sasao, (Editors), Logic Synthesis and Verification, Kluwer Academic publishers, 2002

EC407N TECHNIQUES IN LOW POWER VLSI (3-0-0) 3

Introduction to Low Power VLSI. Modelling and Sources of Power consumption. Power estimation at different design levels. Power optimization for combinational circuits and sequential circuits Voltage scaling Approaches. Low energy computing using energy recovery techniques. Low Power SRAM architectures. Software design for low power. Computer Aided Design Tools. Case studies Recent trends in low-power design for mobile and embedded application.

Kaushik Roy, Sharat Prasad, Low-Power CMOS VLSI design, John Wiley, 2000. K.-S. Yeo and K. Roy, Low-Voltage Low-Power Subsystems, McGraw Hill, 2004.

Anantha P. Chandrakasan & Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer, 1995. Gary K. Yeap, Practical Low Power Digital VLSI Design, Kluwer Academic Publications, 1998
L. Benini and G. De Micheli, Dynamic Power Management Design Techniques and CAD Tools, Springer, 1998.
S. G. Narendra and A. Chandrakasan, Leakage in Nanometer CMOS Technologies, Springer, 2005.
Edgar Sánchez-Sinencio, Andreas G. Andreou, Low- Voltage/Low-Power Integrated Circuits and Systems: Low-Voltage Mixed-Signal Circuits IEEE Press Series on Microelectronic Systems 1999

EC408N SUBMICRON DEVICES (3-0-0) 3

Review of basic device physics, Electronic structure of semiconductors, Diodes, MOS capacitor. Transistor theory. Scaling - Moore's law on technology scaling, MOS device scaling theory, Short channel effects, sub threshold leakage, Punch through, DIBL, High field mobility, Velocity saturation and overshoot. Reliability. Various definitions of channel length, Performance metric of digital technology, Transistor design trade- offs, Technology case studies, Silicon on Insulator (SOI) devices, Partially depleted and fully depleted SOI, Floating body effects, SOI for low power, Interconnects in sub-micron technology, Foundry technology, International Technology Roadmap for Semiconductors (ITRS).

J. A. del Alamo Integrated Microelectronic Devices: Physics and Modelling, Pearson, 2017 Yaun Taur, Tak H. Ning, Fundamentals of modern VLSI devices, Cambridge university press, 1998.
B. G. Streetman & S. Banerjee, Solid State Electronic Devices, Prentice Hall, 1999.
M. K. Achuthan and K. N. Bhat, Fundamentals of Semiconductor Devices, McGraw Hill, 2006 Nandita Dasgupta, Amitava Dasgupta, Semiconductor Devices: Modelling And Technology, Phi, 2009 A. K. Dutta, Semiconductor Devices and Circuits, Oxford Univ. Press, 2008. ITRS Road map - http://public.itrs.net/

EC409N ACTIVE FILTERS (3-0-0) 3

Butterworth, Chebyshev & Inverse-Chebyshev filter response and pole locations, LC ladder filter – prototype & synthesis; Frequency transformation of lowpass filter. Impedance converters; Gm-C filters – Gm-C biquad, Q enhancement, Automatic Tuning; Active-RC filters – Comparison with Gm-C filter, Issues in realizing high frequency active-RC filters, Switched Capacitor Filters.

R. Schaumann and M.E. Van Valkenburg, Design of Analog Filters, Oxford University Press, 2003.
P.V. Ananda Mohan, Current-Mode VLSI Analog Filters - Design and Applications, Birkhauser, 2003 M.E. Van Valkenburg, Analog Filter Design, Oxford University Press, 1995.

EC410N HETEROGENEOUS AND PARALLEL COMPUTING (2-0-2) 3

Heterogeneous platform and GPU architecture. Introduction to OpenCL. OpenCL device architecture. Concurrency and execution model. Programming examples like vector addition, convolution and matrix multiplication. Application case studies.

Benedict R. Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, Dana Schaa, "Heterogeneous Computing with OpenCL" - Revised OpenCL 1.2 Edition, Morgan Kaufmann, 2013.
Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg, "OpenCL Programming Guide", Addison-Wesley, 2012.
David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors - A Hands-on Approach", Second Edition, Morgan Kaufmann, 2013.
AMD Accelerated Parallel Processing OpenCL User Guide, AMD, 2014.

EC411N ALGORITHMS AND ARCHITECTURES FOR SIGNAL PROCESSING (3-0-0) 3

Representation of digital signal processing systems: block diagrams, signal flow graphs, data-flow graphs, dependence graphs; pipelining and parallel processing for high-speed and low power realizations; iteration bound, algorithms to compute iteration bound, retiming of data- flow graphs; unfolding transformation of data-flow graphs; systolic architecture design, architectures for real and complex fast Fourier transforms; stochastic

logic based computing, computing digital filters, arithmetic functions and machine learning functions using stochastic computing; Neural Network architectures.

K.K. Parhi, VLSI Digital signal processing systems: Design and implementation, John Wiley, 1999. Lars Wanhammar, DSP Integrated Circuits, Academic Press, 1999
Sen M. Kuo Bob H. LeeWenshun Tian, "Real-Time Digital Signal Processing: Implementations and Applications", 2006 John Wiley & Sons, Ltd
Roger Woods, John McAllister, Gaye Lightbody, Ying Yi, "FPGA Based Implementation of Signal Processing Systems", John Wile, 2017.
U. Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays", 4th Ed. Springer, 2014

EC412N ADVANCED DIGITAL SIGNAL PROCESSING (3-0-0) 3

Power spectral estimation; Parametric and non-parametric methods of spectral estimation, Linear prediction, Higher order spectral estimation; Adaptive filters and applications. Recursive estimation and Kalman filters Multirate Signal Processing: Decimation Interpolation, DFT filter banks, QMF filter banks, Multiresolution Signal analysis wavelets theory of sub band decompositions, Sub band coding and wavelet transforms, Application of wavelet transforms.

P.P. Vaidyanathan, Multirate systems and Filter banks, Prentice Hall, 1993. S.J. Orfanidis, Optimum Signal Processing, McGraw Hill, 1989.
S. Haykin, Adaptive Filter Theory, Pearson, 1996

EC413N REAL TIME SIGNAL PROCESSING (2-0-2) 3

Introduction to DSP systems and architecture; Arithmetic: Fixed point, floating point and residue arithmetic, Cordic architectures; Real time implementation of SP algorithms on Digital Signal Processors: Architecture and programming; Real time implementation of SP algorithms on Reconfigurable architectures: Architecture and design flow; Issues in implementation of convolution, FIR, IIR and adaptive filters, DCT, Image Filtering, Dynamically reconfigurable architectures for SP, Software Configurable processors, Application case studies in multimedia compression and communication.

Behrooz Parhami, "Computer Arithmetic Algorithms and Hardware Design", Oxford, 2000. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley, 2005
U. Meyer Baesse, "Digital Signal Processing with FPGAs", Springer, 2001
Shehrzad Qureshi, "Embedded Image Processing on the TMS320C6000 DSP" Springer, 2005

EC414N FOURIER AND WAVELET SIGNAL PROCESSING (3-0-0) 3

Hilbert Spaces, Review of sequences and discrete time systems, functions, DTFT, convergence, multi rate systems, polyphase representation, stochastic processes and systems. Continuous time systems, Fourier transform, definition, existence, spectral decay, Fourier series. Sampling and Interpolation–finite dimensional vectors, sequences, functions, periodic functions, approximation and compression polynomial and spline approximation. Localization and uncertainty. Filter banks–Localization, two channel orthogonal filter banks, design, biorthogonal filter banks, design. Local Fourier bases–N channel filter banks, exponentially modulation filter banks, cosine modulated filter banks. Wavelet bases on sequences, Tree structured filter banks, orthogonal, biorthogonal bases, wavelet packets, frames. Wavelet bases on functions–local Fourier transforms.

Martin Vetterli Jelena Kovacevic & Vivek K. Goyal, Foundations of Signal Processing, Cambridge University Press, 2015.
J. Kovacevic, V. K. Goyal and Martin Vetterli, Fourier and Wavelet Signal Processing, Cambridge University Press, 2013
Todd Moon and WC Stirling, Mathematical Methods and Algorithms for Signal Processing, Pearson Education, 2000 Steven, M. Kay, Modern spectral estimation: theory and application, Prentice Hall, 1988

EC415N MATHEMATICAL METHODS FOR SIGNAL AND DATA PROCESSING (3-0-0) 3

Mathematical Foundations–mathematical models, random variables and random processes, Markov and hidden Markov models. Representations and approximations - orthogonality, least squares, MMSE filtering, frequency domain optimal filtering, minimum norm solutions, Iterated reweighted least squares. Linear Operators – Operator norms, adjoint and transposes, geometry of linear equations, least squares and pseudo inverses, applications to linear models.

Subspace methods – Eigen decomposition, KL transform and low rank approximation, Eigen filters, signal subspace techniques – MUSIC, ESPRIT. SVD – matrix structure, pseudo inverse and SVD, system identification using SVD, Total least squares, partial total least squares. Special matrices–Toeplitz matrices, optimal predictors and lattice filters, circulant matrices, properties.

EC416N DATA COMPRESSION AND APPLICATIONS (3-0-0) 3

Data Compression. Speech & image waveform characterization. Predictive coding. Transform coding. Subband coding, VQ based compression, Fractal coding of images. High quality video & audio compression for digital broadcasting. Standards for digital signal compression-data, speech, audio, image & video.

D. Salomon, Data Compression – the complete reference, Springer, 2000.
K. Sayood, Introduction to Data Compression, Pearson Education, 2000. M.Nelson, The data compression book, BPB Publications, 2002.
Jayant & Noll, Digital coding of waveforms-Principles and applications to speech & video, PH, 1984.

EC417N DYNAMICAL SYSTEMS, CHAOS AND FRACTALS (3-0-0) 3

Preliminaries on systems, Eigen values and Eigen vectors, solutions of linear ODEs. Dynamics of linear and nonlinear systems, solutions, attractors, equilibrium point, limit cycles, stability, Linear systems: solutions, stability of autonomous systems, BIBO stability, relation to frequency domain analysis, Nonlinear systems: large-scale notions of stability (Lyapunov functions), linearization. Vector fields of nonlinear systems, limit cycles, Lorenz and Rossler equation, Chua's circuit, Discrete dynamical systems, logistic maps, two-dimensional maps, bifurcations, flows, phase plane analysis. Introduction to fractals, Mandlebrot and Julia sets, iterated function systems, strange attractors, fractal dimension, stable and unstable manifolds, analysis of chaotic time series, multifractals. Applications in control theory, signal processing, digital image modelling, synthesis and compression, chaos communication and Cryptography. Other applications in engineering, natural and social sciences, medicine, economics, ecology, bio and life sciences, and environmental sciences.

S. Stenberg, Dynamical systems, Dover 2010.
MW Hirsch, S. Smale, RL Devaney, Differential equations, dynamical systems, and an introduction to chaos, Academic Press. 2012.
Steven H. Strogatz, Nonlinear dynamics and chaos: with applications to physics, biology, chemistry, and engineering, West-view Press, 2015.
E. Ott, Chaos in dynamical systems, 2nd ed Cambridge University Press, 2002.
S. Wiggins, Introduction to applied nonlinear dynamical systems and chaos, Springer-Verlag, 1990.
Denny Gulick, Encounters with chaos and fractals, 2nd ed CRC Press, 2012.
J.M. Bahi, C. Guyeux, Discrete dynamical systems and chaotic machines: theory and applications, CRC Press, 2013.
M. Barnsley, Fractals everywhere, Academic Press, 1993.

EC418N STATISTICAL ANALYSIS (3-0-0) 3

Preliminaries on matrix theory and probability distributions. Sampling theory: random samples, sampling distribution, statistical inference, estimation of mean and variances, hypothesis testing, statistical tests, goodness of fit. Data analysis: correlation and regression, simple linear regression, multiple linear regressions,

logistic regression, nonlinear regression. The Multivariate Normal Distribution, Estimation of the Mean Vector and the Covariance Matrix, The Distributions and Uses of Sample Correlation Coefficients, The Generalized T2-Statistic, Classification of Observations, The Distribution of the Sample Covariance Matrix and the Sample Generalized Variance, Testing the General Linear Hypothesis: Multivariate Analysis of Variance, Testing Independence of Sets of Variates, Testing Hypotheses of Equality of Covariance Matrices and Equality of Mean Vectors and Covariance Matrices, Principal Components, Canonical Correlations and Canonical Variables, The Distributions of Characteristic Roots and Vectors, Factor Analysis, Pattern of Dependence, Graphical Models.

Sam Kash Kachigan, Statistical Analysis: An Interdisciplinary Introduction to Univariate and Multivariate Methods, Radius Press, 1986.
RA Johnson, DW Wichern, Applied multivariate statistical analysis, 6th ed, PHI, 2012.
T. W. Anderson, An Introduction To Multivariate Statistical Analysis, 3rd Edition, Wiley, 2003.
Sam Kash Kachigan, Multivariate Statistical Analysis: A Conceptual Introduction, Radius Press, 1991.
Robert Nisbet, John Elder and Gary Miner, Handbook of Statistical Analysis and Data Mining applications, Elsevier Inc 2009.

EC419N OPTIMIZATION THEORY AND TECHNIQUES (3-0-0) 3

Convex sets and Convex functions, Level sets and Gradients, Unconstrained Optimization: Search methods, Gradients Methods, Newton Method, Conjugate Direction Methods, Quasi-Newton Methods. Linear Programming: Standard Form Linear Programs, Simplex method, Duality and Non-Simplex Methods. Nonlinear Constrained Optimization: Problems with equality constraints, Problems with Inequality Constraints, Convex Optimization Problems, Algorithms for Constrained Optimization: Projected Gradient Methods and Penalty Methods.

Lieven Vandenberghe and Stephen P. Boyd, Convex Optimization, Cambridge University Press, 2004. Dimitris Bertsimas, John N. Tsitsiklis, Introduction to Linear Optimization, Athena Scientific Series, 1997. Aharon Ben-Tal and Arkadi Nemirovski, Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications, SIAM, 2001.

EC420N UNSUPERVISED LEARNING (3-0-0) 3

Clustering-K means, Hierarchical Clustering, Density-Based Spatial Clustering of Applications with Noise, Gaussian Mixture Models, Association Rule Learning, Dimensionality Reduction, Anomaly Detection, Principal Component Analysis (PCA), SVD, Autoencoders, Variational Autoencoders, Generative Adversarial Networks, Restricted Boltzmann Machines (RBMs) and Deep Belief Networks (DBNs), Self-Organizing Maps (SOMs), Hierarchical Temporal Memory (HTM), use cases: customer segmentation, image recognition, anomaly detection, scientific discovery. Semi-supervised learning, Gaussian mixtures, manifold learning, decomposing signals using matrix factorization problems, density estimation

M. Emre Celebi, Kemal Aydin, Unsupervised Learning Algorithms, Springer, 2018.
Geoffrey Hinton, Terrence J. Sejnowski, Unsupervised Learning: Foundations of Neural Computation, The MIT Press, 1999.
Matthew Kyan, Paisarn Muneesawang, Kambiz Jarrah, Ling Guan, Unsupervised Learning: A Dynamic Approach, Wiley-IEEE Press, 2014.
Giuseppe Bonaccorso, Hands-On Unsupervised Learning with Python, Packt Publishing, 2019.

EC421N SPREAD SPECTRUM COMMUNICATION (3-0-0) 3

Spread spectrum overview, Spreading techniques, Pseudo noise sequences, Direct sequence spread spectrum system, Frequency hop spread spectrum system, Hybrid systems, Synchronization, Jamming considerations, Commercial applications, Cellular systems, Performance of spread spectrum systems.

R.L. Peterson, Introduction to spread spectrum communication, PH,1995. B. Sklar, Digital Communications, Pearson Education, 2001.
M.K. Simon, Spread spectrum communications Handbook, McGraw-Hill, 2001. J.S. Lee, CDMA Systems Engineering handbook, Artech House, 1998

EC422N ERROR CONTROL CODING (3-0-0) 3

Coding for reliable digital transmission and storage. Groups, Rings, Vector Spaces, Galois Fields, Polynomial rings, Channel models, Linear Block codes, Cyclic codes, BCH codes, Reed Solomon Codes, Berlekamp-Massey and Euclid decoding algorithm, Decoding beyond the minimum distance parameter, Applications of Reed-Solomon codes, Convolutional codes, Decoding algorithms for Convolutional codes, Viterbi, Stack and Fano algorithms, Application of Convolutional codes. Codes based on the Fourier Transform, Algorithms based on the Fourier Transform, Trellis coded modulation, Combinatorial description of Block and Convolutional codes, Algorithms for the construction of minimal and tail biting trellises, Soft decision decoding algorithms, Iterative decoding algorithms, Turbo-decoding, Two-way algorithm, LDPC codes, Use of LDPC codes in digital video broadcasting, belief propagation (BP) algorithms, Space-Time codes.

Shu Lin and Daniel J. Costello Jr., Error Control Coding: Fundamentals and Applications, Prentice Hall, 2003. S. B Wicker, Error Control Systems for Digital Communication and Storage, Prentice Hall International, 1995. Blahut R. E, Theory and Practise of Error Control Codes, Addison Wesley, 1983.

EC423N OPTICAL COMMUNICATION SYSTEMS AND NETWORKS (3-0-0) 3

Introduction to Optical Fibers, Ray Optics-Optical Fiber Modes and Configurations. Signal degradation in Optical Fibers. Optical Sources and Detectors. Optical Communication Systems and Networks. Basic concepts of SONET/SDH Networks.

J. Senior, Optical Communication, Principles and Practice, Prentice Hall of India, 1994/latest edition. Gerd Keiser, Optical Fiber Communication McGraw –Hill International, Singapore, 3rd ed., 2000/latest Edition
J. Gower, Optical Communication System, Prentice Hall of India, 2001.

EC424N RADAR SIGNAL PROCESSING (3-0-0) 3

Introduction to Radar Systems and Signal Processing, Signal Models, Pulsed Radar Data Acquisition Radar Waveforms, Doppler Processing, Detection Fundamentals, Introduction to Synthetic Aperture Imaging, and Introduction to Beamforming and Space-Time Adaptive Processing.

Mark A Richards, Fundamentals of radar signal Processing, McGraw Hill edition, 2nd edition, 2013 Peebles P. Z, Radar Principles, John Wiley and Sons, 1998.

EC425N ALGORITHMS FOR PARAMETER AND STATE ESTIMATION (3-0-0) 3

Maximum likelihood (ML) estimation, Maximum a posteriori (MAP) estimation, Least squares (LS) estimation, Minimum mean square error (MMSE) estimation, Linear MMSE (LMMSE) estimation. LS estimation for linear and nonlinear systems, modelling stochastic dynamic systems, the Kalman filter for discrete time linear dynamic systems with Gaussian noise. Steady state filters for noisy dynamic systems, adaptive multiple model estimation techniques. Nonlinear estimation techniques, computational aspects of discrete time estimation.

Y. Bar-Shalom, X. Rong Li and T. Kirubarajan, Estimation with Applications to Tracking and Navigation, John Wiley & Sons, 2001.
F. L. Lewis, Optimal Estimation, John Wiley & Sons, 1986.
R. G. Brown and P. Y. C. Hwang, Introduction to Random Signals and Applied Kalman Filtering, John Wiley & Sons, 1992.

EC452N DETECTION AND ESTIMATION THEORY (3-0-0) 3

Preliminaries on probability and random processes. Hypothesis testing: Neyman-Pearson theorem, likelihood ratio test and generalized likelihood ratio test, uniformly most powerful test, multiple- decision problem, detection of deterministic and random signals in Gaussian noise, detection in nonGaussian noise, sequential detection. Parameter estimation: unbiasedness, consistency, Cramer-Rao bound, sufficient statistics, Rao-Blackwell theorem, best linear unbiased estimation, maximum likelihood estimation, method of moments. Bayesian estimation: MMSE and MAP estimators, Levinson-Durbin and innovation algorithms, Wiener filter, Kalman filter. Applications in Wireless Communication, Radar Systems, Speech, Image and Video processing and applications relevant to Engineering.

Steven Kay, Fundamentals of Statistical Signal Processing - Detection Theory (Vol. 2), Prentice Hall, 1998.
Steven Kay, Fundamentals of Statistical Signal Processing - Estimation Theory (Vol. 1), Prentice Hall, 1993.
H. V. Poor, An Introduction to Signal Detection and Estimation, Springer-Verlag, 2nd edition, 1994.
H. L. Van Trees, Detection, Estimation and Modulation Theory, Parts 1 and 2, John Wiley Inter- Science, 2002
M. D. Srinath, P. K. Rajasekaran and R. Vishwanathan, An Introduction to Statistical Signal Processing with Applications, Prentice-Hall, 1996.
Kailath, T. and Hassibi, Linear Estimation, Pearson, 2000

EC453N ADVANCED TOPICS IN COMMUNICATION ENGINEERING (3-0-0) 3

Fading Channels, characterizing Mobile radio propagation, Signal time spreading, time variance of channel, mitigating the degradation effects of fading, characterizing fading channels, Fundamentals of Statistical Detection Theory, Baye's Theorem, Decision theory, Neyman Pearson Theorem, Receiver operating characteristics, Bayes's risk. Multiple hypothesis testing, minimum Baye's risk detection for binary hypothesis and multiple hypothesis, Orthogonal Frequency Division Multiplexing, OFDM transmission technique, synchronization, modulation, demodulation, amplitude limitation of OFDM signals. Space Time Wireless Communications, Introduction, space time propagation, space time channel and signal models, spatial diversity, space time OFDM

J.G. Proakis & M. Salehi, Digital Communication, 5th edition, McGraw Hill 2007.
Stevan M Kay, Fundamentals of Statistical signal processing, Vol. II, Detection Theory, PHI, 1998.
A. Paulraj, R. Nabar & D. Gore, Introduction to Space Time Wireless Communications, Cambridge University, 2003.

EC454N INTRODUCTION TO PHOTONICS (3-0-0) 3

Photonic Crystals: Electromagnetic wave in periodic medium, Symmetry, 1D photonic crystals: photonic band gap, omnidirectional reflector, 2D photonic crystals: photonic crystal waveguides, micro cavity, negative refraction, self-collimation, photonic crystal fibre, One-way waveguide, 3D photonic crystals: self-assembled photonic crystal, holographically fabricated photonic crystal. Plasmonics, - Optics in metal, Surface Plasmon polariton, Localized surface plasmon, Phonon polariton, Plasmon waveguides, Transmission through sub-wavelength aperture, Enhancement of fluorescence and nonlinearity, Applications in Biomedical Engineering. Metamaterials, Effective medium theory, Negative refractive index, Super lens, Transformation optics, Invisibility cloak.

Lukas Novotny and Bert Hecht, Principles of Nano-Optics, Cambridge University Press, 2012
Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Juan ArielLevenson, Nanophotonics, Wiley-ISTE, 2006. Mark L. Brongersma, Pieter G. Kik, Surface Plasmon Nanophotonics, Springer, 2007
P.N. Prasad, Nanophotonics, John Wiley and Sons, 2004
John D. Joannopoulos, Robert D. Meade, Joshua N. Winn, Photonic Crystals, Princeton University Press Princeton, NJ, USA 2008.

EC455N MIMO COMMUNICATION SYSTEMS (3-0-0) 3

Overview of fundamentals of Digital Communications, The Wireless Channel, Detection, Diversity and Channel Uncertainty, Capacity of Wireless channels, Spatial Multiplexing and Channel modelling, Capacity and Multiplexing architectures, Diversity-Multiplexing trade-off and Universal Space Time Codes, Multi-user Communication.

D. Tse, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005.
E. Biglieri, Coding for Wireless Channels, Springer, 2007
E. Biglieri et al., MIMO Wireless Communications, Cambridge University Press, 2007.

EC456N RF IC DESIGN (3-0-0) 3

Basic concepts in RF Design – harmonics, gain compression, desensitization, blocking, cross modulation, intermodulation, inter symbol interference, noise figure, Friis formula, sensitivity and dynamic range; Receiver architectures – heterodyne receivers, homodyne receivers, image-reject receivers, digital-IF receivers and subsampling receivers; Transmitter architectures – direct-conversion transmitters, two-step transmitters; Low noise amplifier (LNA) – general considerations, input matching, CMOS LNAs; Down conversion mixers – general considerations, spur-chart, CMOS mixers; Oscillators – Basic topologies, VCO, phase noise, CMOS LC oscillators; PLLs – Basic concepts, phase noise in PLLs, different architectures.

Behzad Razavi, RF Microelectronics, Prentice Hall PTR, 1997
Thomas H. Lee, The design of CMOS radio -frequency integrated circuit, Cambridge University Press, 2006
Chris Bowick, RF Circuit Design, Newnes, 2007

EC457N PRINCIPLES OF MODERN RADAR - ADVANCED TECHNIQUES (3-0-0) 3

Advanced Techniques in Modern Radar, Advanced Pulse Compression Waveform Modulations and Techniques, Optimal and Adaptive MIMO Waveform Design, MIMO Radar, Synthetic Aperture Radar, Array Processing and Interference, Mitigation Techniques, Human Detection with Radar: Dismount Detection, Advanced Processing Methods for Passive Bistatic Radar Systems

Mark A Richards, Principles of modern radar (POMR)-Advanced Techniques (Vol-1I), Scitech publishers

EC458N ELECTRONIC DEFENCE SYSTEMS (3-0-0) 3

Electronic Defence: Introduction, Systems in use in Armed forces; Sensors: Radar Sensors, Infrared sensors; Weapon systems: Artillery systems, missile systems; Electronic Intercept Systems: Introduction The Equation of a Passive System, Radar Warning Receivers; Electronic Countermeasures Systems Introduction, Operational Jamming Modes: SPJ, SOJ, and EJ, Onboard ECM Systems, .Electronic Counter-Countermeasures Systems: Introduction, Search Radar Counter-Countermeasures; New Electronic Defence Techniques and Technologies: Introduction, New Electronic Defence Architectures, ESM Antennas, Wideband Front End and Digital Receiver.

Filippo Neri, Introduction to Electronic Defence Systems, Second Edition, Artech House, London

EC459N MILLIMETER WAVE COMMUNICATION (3-0-0) 3

Millimeter wave characteristics and implementation challenges, radio wave propagation for mm wave, Millimeter wave generation and amplification, HEMT, transistor configurations, Analog mm wave components, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's, Modulation for millimeter wave communications, Millimeter wave link budget, Transceiver architecture, Massive MIMO Communications, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation, Antenna beam width, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas,

Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011. Robert W. Heath, Robert C. Daniel, James N. T.S. Rappaport, Murdock, "Millimeter Wave Wireless Communications", PH, 2014.
Xiang, W.Zheng, K. Shen, X.S, "5G Mobile Communications", Springer, 2016.

EC460N COMPUTATIONAL INVERSE PROBLEMS AND IMAGING (3-0-0) 3

Inverse Problems and Interpretation, Examples of inverse problems, III posed problems and numerical solutions. Classical Regularization Methods, Statistical Inversion Theory, nonstationary Inverse Problems, Regression, regularization, and iterative schemes for smooth optimization, numerical optimization, Bayesian approach to inverse problems. Physics of imaging, Imaging methods and modalities, computational aspects, theoretical and applied; modalities in medical imaging, geophysics, applied physics, biology, astronomy, remote sensing and optics; methods and applications in nuclear medical imaging physics and radiology, image guided radiotherapy; RADAR, computational photography, inverse problems and reconstruction, image informatics.

Curtis R. Vogel, Computational Methods for Inverse Problems, SIAM, 2002.
Per Christian Hansen, Discrete Inverse Problems: Insight and Algorithms, SIAM, 2010. Jennifer Mueller and Samuli Siltanen, Linear and Nonlinear Inverse Problems with Practical Applications, SIAM, 2012.
Kedar Khare, Fourier Optics and Computational Imaging, Wiley, 2015.
E. Russell Ritenour and William Hendee, Medical Imaging Physics, Wiley 2002. Thayalan K, The Physics of Radiology and Imaging, Jaypee Brothers 2014.

EC461N ADVANCED DEEP LEARNING AND APPLICATIONS (2-0-2) 3

Review of CNNs for classification and segmentation tasks, Advance concepts-depth-wise separable convolution, Atrous convolution, Group Convolution, Gated Atrous Pyramid Pooling, Attention and Self-attentions. Deep CNN Models for Regression, classification and Segmentations task: ResNet Models, Variants of UNet, BiSeNet V2. Advance CNNs for Object Detection and Text Classification, Graph Neural Networks. Vision Transformer and its Applications: object segmentation, detection and classification.

IanGoodfellow, YoshuaBengio, and Aaron Courville Deep Learning, MIT Press, 2016.
Mahmoud Hassaballah and Ali Ismail Awad, Deep Learning in Computer Vision: Principles and Applications, CRC Press, 2020.
Rowel Atienza, Advance deep learning with Keras, Packt, October 2018.
Wang, X., Zhao, Y.&Pourpanah, F. Recent advances in deep learning. Int.J.Mach. Learn. & Cyber. 11,747-750 (2020). https://doi.org/10.1007/s13042-020-01096-5
Alexey Dosovitskiy, et al., An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale, https://arxiv.org/abs/2010.11929
Xiangning Chen, Cho-Jui Hsieh, Boqing Gong, "When Vision Transformers Outperform ResNets Without Pre-Training or Strong Data Augmentations", 2022

EC462N MATHEMATICS OF DATA SCIENCE (3-0-0) 3

Extracting information from data, Mathematics as a foundation of data science, Data Science models and methods, data science revolution, Topics from real analysis and functional analysis, matrix algebra, multivariate calculus, differential equations, geometry and topology. Data visualization, mining and knowledge discovery, geometry and high dimension, dimension reduction, high-dimensional statistics, Concentration of Measure, graphs and networks, dimension and Semi-supervised learning, Matrix concentration inequalities, Manifold Learning and Diffusion Maps, Compressive Sensing and Sparsity, tensor decomposition, learning for

control and dynamical systems, physics of information, Quantum Machine Learning, Solving complex problems.

Avrim Blum, John Hopcroft, and Ravindran Kannan, Foundations of Data Science, 2018.
Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, 2020.
Jingli Ren, H Wang, Mathematical Methods in Data Science, Elsevier, 2023.
Daniela Calvetti and Erkki Somersalo, Mathematics of Data Science: A Computational Approach to Clustering and Classification, SIAM, 2020.
Barend Mons, Data Stewardship for Open Science: Implementing FAIR Principles, CRC Press, 2021.
Herbert Jones, Data Mining, Bravex Publications, 2020.

EC463N ANTENNAS FOR WIRELESS COMMUNICATIONS (3-0-0) 3

Antenna fundamentals, antenna arrays, and basic types of antennas for wireless communication. Review of Electromagnetic theory. Mathematical solution of Maxwell's equations for radiation problems. Basic antenna parameters. Electrically small antennas. Theory of receiving antennas. Topics in antenna arrays include the array factor, pattern multiplication, multidimensional arrays, phased arrays, and smart antennas. Several types of antennas including wire, microstrip, and aperture antennas. Concepts, tools, and practice of antenna analysis, measurement, and design.

Antenna Theory and Design, Second Edition, Warren L. Stutzman and Gary A. Thiele, John Wiley & Sons, 1998.
Antenna Theory: Analysis and Design, Constantine A. Balanis, Second Edition, John Wiley & Sons, 1997.
Antennas for All Applications, Third Edition, John D. Kraus and Ronald J. Marhefka, McGraw Hill, 2002.

EC464N QUANTUM INFORMATION PROCESSING (3-0-0) 3

Linear Algebra and Quantum Mechanics, Dirac Notation, Hermitian Operator, Pauli Matrices, Tensor product, Hilbert space, Quantum Mechanics— Postulates, Hamiltonian operator, dual space, bracket, Two-State System, Qubit and the Bloch Sphere, Quantum Entanglement, Computation on a Quantum Computer, Quantum algorithms and computing, Quantum error correction and fault tolerance, Quantum cryptography and communications, Decoherence and open quantum systems, quantum systems: Nuclear magnetic resonance (NMR), Spin control, Superconducting qubits, Quantum optics, quantum imaging and sensing, quantum computer science, Computational Complexity and Quantum Circuits, Universal Quantum Gates, Quantum Fourier Transforms and Phase Estimation Algorithms, Shor's Algorithm and Grover's Search, Ensembles of Quantum States, Spin and its dynamics, Density matrices and Von Neumann entropy.

John Watrous, The Theory of Quantum Information, Cambridge University Press, 2018. Mikio Nakahara, Tetsuo Ohmi, Quantum Computing: From Linear Algebra to Physical Realizations, CRC Press 2008.
Nielsen, Chuang, Quantum Computation and Quantum Information, 10th ed., Cambridge University Press, 2010.
David Mermin, Quantum computer science, An introduction, Cambridge University Press 2000.
Neil Gershenfeld, The physics of information technology, Cambridge University Press, 2000. Michel Le Bellac, A short introduction to quantum information and quantum computation, Cambridge University Press. 2012.

EC465N QUANTUM ELECTRONICS (3-0-0) 3

Principles of Quantum Mechanics- Energy Quanta, Wave–Particle Duality, The Uncertainty Principle Schrodinger's Wave Equation, Extension of the Wave Theory to Atoms, Allowed and Forbidden Energy Bands-Formation of Energy Bands, The Kronig–Penney Model, K Space Diagram, Electrical Conduction in Solids-The Energy Band and the Bond Model, Electron Effective Mass, Density of States Function, Statistical Mechanics- The Fermi Dirac Probability Function, The Distribution Function and the Fermi Energy, Quasi Fermi Level, Quantum materials, Introduction to Qubits, Properties of Qubits. Architecture of Quantum Computers, Interfacing Quantum Processor with Classical Controllers, Quantum Gates and Operations,

Quantum Entanglement, Single Qubit System, Extension to multi-Qubit systems, Multiplexing DC and I/O signal for 4 qubits, Future trends –Number of Qubits required, Quantum Gate Operations and Quantum Circuits, Introduction to quantum sensing, Qubit readout front-end circuits for Spin qubit and Transmon qubit, Sensing the Qubits, Recapitulation.

D. Neamen, "Semiconductor physics and devices: basic principles," McGraw Hill New York, NY: 2012. Chien, Wei Chen, Shun Jhou Jhan, Kuei Lin Chiu, Yu xi Liu, Eric Kao, and Ching Ray Chang. 2020. "Cryogenic Materials and Circuit Integration for Quantum Computers." Journal of Electronic Materials 49 (11): 6844–58.
Patra, Bishnu, Rosario M. Incandela, Jeroen PG Van Dijk, Harald AR Homulle, Lin Song, Mina Shahmohammadi, Robert Bogdan Staszewski et al. "Cryo-CMOS circuits and systems for quantum computing applications." IEEE Journal of Solid-State Circuits 53, no. 1 (2017): 309-321.
Introductory Quantum Optics, C. Gerry and P. Knight, Cambridge University Press, 2005. Quantum Electronics, A Yariv, John Wiley, NY, 1989.

EC466N QUANTUM NEURAL NETWORKS (2-0-2) 3

Review of Machine Learning Algorithm, Introduction to Quantum Computing-state vectors, Hilbert space, quantum states, quantum entanglement and superposition, quantum gates, and quantum circuits, Introduction of quantum computing algorithms; Quantum machine learning (QML) basics; including representing classical data on quantum systems, quantum data encoding and embedding, quantum data representation and quantum feature maps.; Quantum Algorithms for Machine Learning; Quantum Classifiers, Quantum Kernel Methods, and Quantum Clustering.Quantum Variational Circuits, Quantum Neural Networks (QNNs), Quantum Convolutional Neural Networks (QCNNs), Quantum Federated Learning (QFL), Quantum Reinforcement Learning (QFL), Quantum Multimodal Learning. Applications and future research directions-Applications of QML in natural language processing, computer vision, healthcare, drug design, transportation, and intrusion detection.

Tom M. Mitchell, "Machine Learning", 2017, Mc-Graw Hill, Publisher
Chris Bernhardt's "Quantum Computing for Everyone", 2019, MIT Press.
Claudio Conti, "Quantum Machine Learning", 2024 edition, Springer Publisher
Santanu Pattanayak, "Quantum Machine Learning with Python", 2021, Apress Publisher
Sarah C. Kaiser and Christopher Granade, "Learn Quantum Computing with Python and Q: A hands-on approach".

EC467N INTRODUCTION TO GEN AI (2-0-2) 3

Deep learning Review - MLP/CNN/RNN, self-attention, scaled-dot product attention, multi-head blocks, positional encoding, Transformer architecture, seq2seq task in Colab Text Understanding & Generation in Colab - Encoder-only (BERT) fine-tuning for classification & QA, Decoder-only (GPT-2) text generation, sampling strategies, Seq2seq (T5/BART) summarization & translation, ROUGE Scoring Audio & Music Generation - wav2vec 2.0 for ASR (self-supervised pre-training + fine-tuning), VQ-VAE tokenization for raw audio synthesis, Music Transformer for symbolic melody generation Vision & Video Vision Transformer (ViT) for image classification, CIFAR-10 in Colab; compare to ResNet baseline Latent Diffusion (Stable Diffusion) for text-to-image, Hugging Face Diffusers; generate 256×256 images Video Transformers (ViViT/TimeSformer), Simple Video Transformer for action recognition on short clips.

Deep Learning by Goodfellow, Bengio, and Courville, Hardcover Book on Artificial Intelligence, MIT Press 2016.
Natural Language Processing with Transformers, Revised Edition 1st Edition, Lewis Tunstall, Leandro von Werra, Thomas Wolf, O'Reilly 2022
Hands-On Generative AI with Transformers and Diffusion Models Omar Sanseviero, Pedro Cuenca, Apolinario Passos and Jonathan Whitaker, O'Reilly 2024.

EC398N/ EC448N/ EC498N INTERNSHIP – I/ II/ III **(0-0-18) 9**

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

EC399N MAJOR PROJECT - I **(0-0-18) 9**

EC449N MAJOR PROJECT - II **(0-0-18) 9**

EC499N MAJOR PROJECT - III **(0-0-18) 9**

Department of Information Technology (IT)
Bachelor of Technology in Information Technology

Basic Science Courses (BSC)

PH100N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
MA103N	Linear Algebra	(3-0-0)3
MA105N	Probability and Statistics	(3-0-0)3
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

CS101N	Computer Programming	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
UC101N	Introduction to Engineering	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC)

IT200N	Object Oriented Programming	(1-0-4)3
IT201N	Computer Communication and Networks	(3-0-0)3
IT202N	Computer Organization and Architecture	(3-0-0)3
IT203N	Discrete Mathematics	(2-0-2)3
IT204N	Data Structures	(3-0-0)3
IT205N	Computer Communication and Networks Lab	(0-0-2)1
IT206N	Python Programming	(0-0-2)1
IT207N	Data Structures Lab	(0-0-2)1
IT250N	Design and Analysis of Algorithms	(3-0-0)3
IT251N	Database Systems	(3-0-0)3
IT252N	Operating Systems	(3-0-0)3
IT253N	Design and Analysis of Algorithms Lab	(0-0-2)1
IT254N	Database Systems Lab	(0-0-2)1
IT255N	Operating Systems Lab	(0-0-2)1
IT256N	Data Analytics and Machine Learning Lab	(0-0-6)3
IT300N	Software Engineering	(1-0-4)3
IT301N	Distributed Computing Systems	(3-0-0)3
IT302N	Information Assurance and Security	(2-0-2)3
IT303N	Distributed Computing Systems Lab	(0-0-2)1
IT304N	Web Technologies and Applications	(1-0-4)3
IT305N	Theory of Computation	(2-0-0)2

Department/Institute Elective Courses (DEC)

IT275N	Information Systems	(3-0-0)3
IT276N	Paradigms of Programming	(3-0-0)3
IT277N	Computer Graphics	(3-0-0)3
IT278N	Microprocessors and Interfacing	(3-0-0)3
IT279N	Performance Modelling	(3-0-0)3
IT280N	Mathematical Foundations for IT	(3-0-0)3
IT281N	Embedded Systems	(3-0-0)3
IT282N	Bioinformatics	(3-0-0)3
IT283N	Knowledge Management	(3-0-0)3
IT284N	Competitive Programming	(3-0-0)3
IT350N	Soft Computing	(3-0-0)3
IT351N	Genetic Algorithms	(3-0-0)3
IT352N	Artificial Neural Networks	(3-0-0)3
IT353N	Fuzzy System Models	(3-0-0)3
IT354N	Data Warehousing and Data Mining	(3-0-0)3
IT355N	Middleware Technologies	(3-0-0)3
IT356N	Technologies for Internet of Things	(3-0-0)3
IT357N	Wireless Sensor Networks	(3-0-0)3
IT358N	Mobile Adhoc Networks	(3-0-0)3
IT359N	Semantic Web Technologies	(3-0-0)3
IT360N	Virtual Reality	(3-0-0)3
IT361N	Web Services	(3-0-0)3
IT362N	Software Architecture	(3-0-0)3
IT363N	Software Quality Assurance	(3-0-0)3
IT364N	Linux Kernel Internals	(3-0-0)3
IT365N	Number Theory and Cryptography	(3-0-0)3
IT366N	Cyber Security	(3-0-0)3
IT367N	Deep Learning	(3-0-0)3
IT368N	Software System Design	(3-0-0)3
IT369N	User Experience Design	(3-0-0)3
IT370N	Mobile Computing	(3-0-0)3
IT371N	Compiler Design	(3-0-0)3
IT400N	Advanced Computer Networks	(3-0-0)3
IT401N	Perceptual Audio Processing	(3-0-0)3
IT402N	Perceptual Video Processing	(3-0-0)3
IT403N	Computer Vision	(3-0-0)3
IT404N	Pattern Recognition	(3-0-0)3
IT405N	Information Technology for Healthcare	(3-0-0)3
IT406N	Natural Language Processing	(3-0-0)3
IT407N	Information Retrieval	(3-0-0)3
IT408N	Advanced Database Systems	(3-0-0)3
IT409N	Cryptocurrencies and Blockchain Technologies	(3-0-0)3
IT410N	Robotic Process Automation	(3-0-0)3
IT411N	Quantum Computing	(3-0-0)3
IT412N	Large Language Models	(3-0-0)3
IT413N	Applied Algorithms	(3-0-0)3
IT414N	Randomized Algorithms	(3-0-0)3
IT415N	Approximation Algorithms	(3-0-0)3
IT416N	Privacy Preserving Machine Learning	(3-0-0)3
IT417N	Trustworthy Machine Learning	(3-0-0)3
IT418N	Advanced Algorithms	(3-0-0)3
IT419N	Advanced Data Structures	(3-0-0)3
IT420N	Post Quantum Cryptography	(3-0-0)3

IT421N	Secure Multiparty Computation	(3-0-0)3
IT422N	Advanced Computer Architecture	(3-0-0)3
IT423N	Transaction Processing	(3-0-0)3
IT424N	Social Network Analysis	(3-0-0)3
IT425N	Next Generation Communications	(3-0-0)3
IT426N	Finance Technology	(3-0-0)3
IT427N	NoSQL Databases	(3-0-0)3
IT428N	Medical Image Processing	(3-0-0)3
IT429N	Fundamentals of 5G	(3-0-0)3
IT430N	Narrowband Internet of Things	(3-0-0)3
IT431N	Time Series Analysis	(3-0-0)3
IT432N	System Integration	(3-0-0)3
IT433N	Rich Internet Applications	(3-0-0)3
IT434N	Enterprise Resource Planning and Systems	(3-0-0)3
IT435N	Simulation and Modelling	(3-0-0)3
IT436N	E-Commerce	(3-0-0)3
IT437N	Privacy Preserving Data Publishing	(3-0-0)3
IT438N	Cloud and Data Intensive Applications	(3-0-0)3

Internship

IT398N	Internship I	(0-0-18)9
IT448N	Internship II	(0-0-18)9
IT498N	Internship III	(0-0-18)9

Major Project

IT399N	Major Project I	(0-0-18)9
IT449N	Major Project II	(0-0-18)9
IT499N	Major Project III	(0-0-18)9

Honors Courses

Students seeking Honors degree shall credit minimum FIFTEEN (15) additional credits from minimum FIVE Post graduate courses offered by the Department of Information Technology, as decided by DUGC.

Suggested Plan of Study for B.Tech. in Information Technology:

Semester	I	II	III	IV	V	VI	VII	VIII
1	PH100N	CY100N	IT200N	IT250N	IT300N	IT398N/ IT399N	IT448N/ IT449N	IT498N/ IT499N
2	MA103N	MA105N	IT201N	IT251N	IT301N	Elective 1	Elective 4	Elective 6
3	CS101N	DE100N	IT202N	IT252N	IT302N	Elective 2	Elective 5	Elective 7
4	UC101N	UC101N	IT203N	IT253N	IT303N	Elective 3	Honors / Minor	Honors / Minor
5	UC102N	UC103N	IT204N	IT254N	IT304N	Honors / Minor		
6	PL1XWN / PL1X9N	PL1YWN / PL1Y9N	IT205N	IT255N	IT305N			
7			IT206N	IT256N	PL3XWN / PL3X9N			
8			IT207N	Dept. Elective *	Honors / Minor			
9			PL2XWN / PL2X9N	PL2YWN / PL2Y9N				
10				Honors / Minor				

Requirements for B.Tech. in Information Technology:

Category of Courses	Minimum Credits to be Earned
Basic Science Core (BSC)	20
General Engineering Courses (GEC)	12
Programme Core Courses (PCC)	48
Elective Courses (EC)	24 (21+3*)
Internship / Major Project	27
Life Skill	20
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

*** Department Elective**

IT200N OBJECT ORIENTED PROGRAMMING (1-0-4) 3

Fundamentals of OOP: classes and objects, abstraction, encapsulation, inheritance, polymorphism, and message passing, object creation, memory management, and basic exception handling using an object-oriented language such as Java or C++. Exercises on dynamic binding, templates/generics, file handling, and standard libraries (STL in C++ and Collections Framework in Java), enabling comparison between the two languages. Factory, Abstract Factory.

Schildt, H. (2022). Java: The complete reference (12th ed.). McGraw Hill Education.
Stroustrup, B. (2013). The C++ programming language (4th ed.). Addison-Wesley.
Booch, G., Rumbaugh, J., & Jacobson, I. (2005). The unified Modelling language user guide (2nd ed.). Addison-Wesley.
Freeman, E., Robson, E., Bates, B., & Sierra, K. (2020). Head first design patterns (2nd ed.). O'Reilly Media.
Gamma, E., Helm, R., Johnson, R., &Vlissides, J. (1994). Design patterns: Elements of reusable object-oriented software. Addison-Wesley.

IT201N COMPUTER COMMUNICATION AND NETWORKS (3-0-0) 3

Evolution of Data Communication and Networks, Layered Architecture of Computer Networks, OSI & TCP/IP Architectures. Communication Medium and Networking elements, Line Coding, Data Link Control and Protocols, Error Detection and Correction, and Flow Control. Network Layer Functionalities, IPv4 and IPv6 addressing, and Packet Structure. Routing algorithms. Transport Layer Functionalities, Process-to-Process Communication, UDP and TCP Detailed Study, Congestion Control Algorithms, Presentation and Application Layer Introduction.

Computer Networks, by Andrew S Tanenbaum and David J Wetherall, 6th Edition, 2022, Pearson Education
Data Communication and Networking, Behrouz A Forouzan, 5th Edition, 2017, McGraw-Hill

IT202N COMPUTER ORGANIZATION AND ARCHITECTURE (3-0-0) 3

Fundamentals of Digital Systems, Number System, Introduction to computer organization and architecture, CPU Organization, Data Representation, Instruction Sets, Data path design, Fixed point and floating point arithmetic operations and hardware design, ALU design, Control unit: Hardwired control unit and Micro programmed control unit. Memory organization, Cache memory, Virtual memory. Input output Unit: Programmed Controlled I/O Transfer, Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Pipelining, Performance evaluation.

Carl Hamacher et al., Computer Organization and Embedded Systems, Sixth Edition, McGraw-Hill, 2014.
Vincent P Heuring, Harry F Jordan, T. G. Venkatesh, Computer Systems Design and Architecture, Pearson, 2008. Miles
Murdocca and Vincent Heuring, Computer Architecture & Organization An Integrated Approach, Wiley, 2007.
J. Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017.

IT203N DISCRETE MATHEMATICS (2-0-2) 3

Sets, Basic Logic, Propositional Logic. Proof Techniques: Direct Proof, Contrapositive Proof, Proof by Contradiction, Proving Non-conditional Statements, Proofs involving sets, Disproof, Mathematical Induction, Second Principle of Mathematical Induction, Recursive mathematical definitions. Well-Ordering Principle. Number Theory: Divisibility theory of integers including proofs of results, Primes and their distribution, theory of congruences, and Proving Fermat's theorem, Wilson's theorem, and Euler's theorem. Counting, Pigeonhole Principle, Combinatorial Proof. Relations, Functions, Recurrence relations, Solving recurrence relations, Groups, Rings, Fields, Vector Spaces. Graph Theory.

R.P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition, Pearson, 2008. Kenneth Rossen, Discrete Mathematics and its Application, 7th Edition, McGraw-Hill, 2011.

B. Kolman, R.C. Busby, S.C. Ross, Discrete Mathematical Structures, 6th Edition, Pearson, 2017
Topics in Algebra, I.N. Herstein, Wiley, 1975.
C. L Liu, Elements of Discrete Mathematics, McGraw-Hill Inc, 1985. László Lovász, JózsefPelikán, Katalin Vesztergombi, Discrete Mathematics: Elementary and Beyond., Springer 2003.

IT204N DATA STRUCTURES (3-0-0) 3

Elementary Data Types and Abstract Data Types. Computational model and complexity of algorithms (running time and space metrics), Introduction to Asymptotic notation; Worst-case, Best-case, Average-case and amortized analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT and its implementation using arrays and linked lists. Types of linked lists: Single, Double, circular linked lists and their applications. Stack ADT and Queue ADT implementations with applications. Dynamic set ADT and Dictionary ADT. Hash tables – collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, B-trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Bubble sort, Selection sort, insertion Sort, Merge sort and Quick sort. Linear-time sorting algorithms like Radix and Counting sort. Graphs: Definitions and representations. Depth-first and breadth-first search and their applications.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.
Alfred V Aho, John E Hopcroft, Jeffrey D Ullman, "Data Structures and Algorithms", Addison Wesley, 2003.
T H Cormen, C E Leiserson, R L Rivest, and C Stein, Introduction to Algorithms, 3rd Edition, PHI Learning, 2010.
S. Horowitz. Fundamentals of Data Structures in C, Universities Press, 2nd Edition, 2008.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Knuth D.E., The Art of Computer Programming, Vol. I: Fundamental Algorithms, Addison Wesley, 3rd Ed., 1997.
Mark Allen Weiss, Algorithms Data structures and problem solving with C++, Addison Wesley,1996
Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Pearson, 2011

IT205N COMPUTER COMMUNICATION AND NETWORKS LAB (0-0-2) 1

Design and Simulate different types of network topology; Socket programming, configure Router and Switches using open source tools such as packet tracer. Writing a program/scripts to measure incoming and outgoing network traffic, analyzing the packet structure using tools like Wireshark.

IT206N PYTHON PROGRAMMING (0-0-2) 1

Introduction to Programming Languages, Python Basics, Variables and Data Types, Control Structures, Repetition structures, Functions and Modules, Strings, Lists, File Input and Output, Basic Data Structures, NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data, Python web frameworks.

Martin C. Brown, Python: The Complete Reference, McGraw Hill Education; Fourth edition, 2018
Mark Summerfield, Programming in Python 3: A Complete Introduction to the Python Language, Pearson, 2018

IT207N DATA STRUCTURES LAB (0-0-2) 1

Implementation of List ADT operations using arrays and linked lists. Applications of Lists. Stacks, Queues, and Circular Queues implementation and application. Implementing Hash Tables with chaining and open addressing. AVL tree implementation, B-tree implementation, Application of trees. Array and pointer-based implementation of Binary heaps. Applications of Priority Queues. Searching and sorting. Applications to real-world problems.

IT250N DESIGN AND ANALYSIS OF ALGORITHMS (3-0-0) 3

Models of computation, Proof techniques for correctness, Proving correctness of recursive and non-recursive algorithms, algorithm analysis and asymptotic notation, time and space complexity, average and worst-case analysis, lower bounds. Recurrence Tree and Master Method. Amortised analysis. Basics of recursion divide and conquer (Integer Multiplication, Inversions, Closest Pair of Points, Merge Sort, Quicksort etc.) with proof of correctness and analysis, greedy algorithms (scheduling, Huffman coding, Minimum Spanning tree algorithms, Shortest Path Algorithms etc.) with correctness proofs, dynamic programming (Knapsack, Matrix Multiplication, Optimal Binary Search Tree, Weighted Independent Set, Interval Scheduling etc.) with correctness proofs, Backtracking and branch-and-bound. The applications of the Techniques. Introduction to Randomised Algorithms (Game Tree Evaluation, Quicksort, Order statistics, Min-Cut problem, etc). Reductions and the theory of NP Completeness: Class P, NP, NP-Complete, Proving problems are NP-Complete: 3-SAT, Vertex Cover, Subset-Sum, Partition, Introduction to Approximation algorithms.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S. Dasgupta, C. Papadimitriou, and U. Vazirani, Algorithms, McGraw-Hill Education, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3rd Edition, PHI, 2010.
Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2nd Edition, 2013.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2nd Edition, 2009
Michael R. Garey, David S. Johnson, Computers and Intractability: A Guide to the Theory of NP-completeness, W.H. Freeman& Co Ltd, 1979.

IT251N DATABASE SYSTEMS (3-0-0) 3

Basic Concepts, Data models: ER, EER; Logical Database Design: Normalization; Physical Database Design: Storage organization, Indexing; Query Languages – Procedural, Non-procedural, SQL; Query Processing, Transaction processing: Concurrency Control and Recovery; Current trends in database systems.

Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2014
R. Elmasri and S.B Navathe, Fundamentals of Database Systems,7th Ed., Pearson, 2017
Silberschatz, Korth A.F., Sudarshan S., Database System Concepts, 6th Ed., McGraw-Hill,2010.

IT252N OPERATING SYSTEMS (3-0-0) 3

Operating Systems Overview, Interrupt Sources and Priorities, Interrupt Service Routines; User and Kernel Threads, Synchronization, Critical Section Problem; Process Synchronization and Coordination, Semaphores, Monitors; Inter Process Communication; Deadlock Prevention, Avoidance, Detection, Recovery; CPU Scheduling Algorithms, Memory Management- Paging and Virtual Memory, Storage Hierarchy, File System Organization; Mobile Operating Systems: ARM & Intel Architectures, Mobile OS Architectures, Runtime Issues, Approaches to Power Management; Introduction to device drivers.

Andrew S. Tannenbaum and Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2015
Abraham Silberschatz et al., Operating System Concepts, 9th Ed., John Wiley, 2012.
Harvey M. Deitel et al., Operating System, 3rd Edition, Pearson, 2007.
William Stallings, Operating Systems: Internals and Design Principles. 9th Ed., Pearson, 2017.
M. J. Bach. Design of the Unix Operating System, 1st Edition, Pearson, 2015.

Jonathan Corbet et al., Linux Device Drivers, 4th Edition, O'Reilly, 2013.

IT253N DESIGN AND ANALYSIS OF ALGORITHMS LAB (0-0-2) 1

Design and Implementation of algorithms using the following: Divide and Conquer, Greedy method, Dynamic Programming, Backtracking, Branch and Bound, Randomized Algorithms.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3rd Edition, PHI, 2010.
Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2nd Edition, 2013.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2nd Edition, 2009

IT254N DATABASE SYSTEMS LAB (0-0-2) 1

SQL, Design of Database Systems for applications Normalization and Query Processing (in terms of disk accesses). Implementation of a few key functionalities of relational database management systems.

IT255N OPERATING SYSTEMS LAB (0-0-2) 1

Basic Unix Commands, Shell programming, Pthreads, Implementation of Synchronization problems using Semaphores, Pipes, Named pipes, Message Queues and Shared Memory, Implementation of Memory Management - Allocation, Placement and replacement Algorithms, File systems implementation.

IT256N DATA ANALYTICS & MACHINE LEARNING LAB (0-0-6) 3

Data analytics process and lifecycle, types of data, data cleaning, Techniques for handling missing data, noisy data, and inconsistent data. Exploratory data analysis, descriptive statistics, correlation analysis, data visualization and visual analytics. Feature engineering, categorical encoding, normalization and standardization, dimensionality reduction – PCA, SVD, IGA. Introduction to machine learning, learning paradigms, training validation and test splits, model evaluation metrics. Supervised learning techniques, model training, hyperparameter tuning and cross validation. Unsupervised learning techniques - hierarchical and density-based clustering, association rule mining. Introduction to time series analysis and forecasting, anomaly and outlier detection. End-to-end DA-ML workflow using Python based libraries, Case studies and mini projects using diverse real-world datasets.

AurélienGéron, Hands On Machine Learning with Scikit Learn, Keras and TensorFlow, 3rd Edition, O'Reilly Media, 2022.
Nathan George, Practical Data Science with Python, Packt Publishing, 2022.
Frank Kane, Hands On Data Science and Python Machine Learning, Packt Publishing, 2019.
Alvaro Fuentes, Hands On Predictive Analytics with Python, Packt Publishing, 2018.
Jake VanderPlas, Python Data Science Handbook, 2nd Edition, O'Reilly Media, 2023.
Joel Grus, Data Science from Scratch, 2nd Edition, O'Reilly Media, 2019.
Stefanie Molin, Hands On Data Analysis with Pandas, 2nd Edition, O'Reilly Media, 2022

IT300N SOFTWARE ENGINEERING (1-0-4) 3

Fundamentals of Software Engineering: software characteristics, software process models including Waterfall, V-Model, Spiral, Incremental, Iterative, and Agile methodologies; DevOps practices, Software Requirements Engineering. Software Design and Modelling. Software Construction and Testing. Software Maintenance and Evolution and predictive maintenance: Contemporary Industry Practices: microservices architecture, automated deployment pipelines, DevSecOps practices, and software quality metrics. Practical labs include requirement analysis, UML Modelling, automated testing, CI/CD pipeline setup, and deployment exercises to provide hands-on exposure aligned with modern industry standards.

Bass, L., Weber, I., & Zhu, L. (2015). DevOps: A software architect's perspective. Addison-Wesley.
Kim, G., Debois, P., Willis, J., & Humble, J. (2016). The DevOps handbook: How to create world-class agility, reliability, & security in technology organizations. IT Revolution Press.
Fowler, M. (2018). Refactoring: Improving the design of existing code (2nd ed.). Addison-Wesley.
Morris, J., & Pollice, G. (2019). Site reliability engineering: How Google runs production systems. O'Reilly Media.
Humble, J., & Farley, D. (2010). Continuous delivery: Reliable software releases through build, test, and deployment automation. Addison-Wesley.
Ian Sommerville, Software Engineering, Pearson College Div, 2010

IT301N DISTRIBUTED COMPUTING SYSTEMS (3-0-0) 3

Basic concepts - Computer networks, Distributed systems models and architectures, Design goals, Fundamental issues and transparencies in DCS, Ordering of events, Ordering of messages and concerned protocols, Global state detection, Process synchronization, Process communications, Distributed deadlock handling, Distributed scheduling, Load balancing techniques.

Mukesh Singhal and Niranjan G. Shivaratri, Advanced Concepts in Operating Systems, Tata McGraw-Hill, 2014.
Ajay.D. Kshemkalyani, Mukesh Singhal, Distributed Computing, Cambridge University Press, 2008
A.S Tanenbaum and M.V. Steen, Distributed Systems – Principles and Paradigms, PHI, 2015.
Randy Chow, Distributed Operating Systems and Algorithms, Addison-Wesley, 1997.G.F. Coulouies et al., Distributed Systems: Concepts and Design, Addison Wesley, 5th Ed., 2012.

IT302N INFORMATION ASSURANCE AND SECURITY (2-0-2) 3

Cryptography: Private and Public Key Encryption. Use of Encryption: Digital Signature, Digital Certificates, etc. Authentication: User Authentication, Entity Authentication, Message Authentication, Kerberos Authentication etc. Network Security Tools: Firewalls, Intrusion Detection, etc, Program Security: Non malicious program errors such as Buffer Overflow, Virus and other malicious code, controls against program threats. Protection in Operating Systems

William Stallings, Network Security Essentials: Applications and Standards, Fourth Edition, William Stallings, Pearson Education, 2008.
William Stallings, Cryptography and Network Security Principles and Practice, Fifth Edition, Prentice Hall.
Behrouz A. Forouzan, Introduction to Cryptography and Network Security", Behrouz A. Forouzan
Atul Kahate, Cryptography & Network Security, 4th Edition, Published, May 8, 2019.
Yi Qian James Joshi David Tipper Prashant Krishnamurthy, Information Assurance—Dependability & Security in Networked Systems, Yi Qian James Joshi David Tipper Prashant Krishnamurthy, Morgan Kaufmann, 2008.
N. Nedjah, Springer, Nadia Nedjah, Ajith Abraham, Computational Intelligence in Information Assurance and Security, N. Nedjah, Springer, Nadia Nedjah, Ajith Abraham,
Christof Paar, Jan Pelzl- Understanding Cryptography, Springer, 2014.

IT303N DISTRIBUTED COMPUTING SYSTEMS LAB (0-0-2) 1

Parallel Programming Models and Languages: OpenMP, MPI. Exercises based on parallel programming, implementation of the distributed algorithm as a case study.

IT304N WEB TECHNOLOGIES AND APPLICATIONS (1-0-4) 3

Internet and World Wide Web – Web system architecture, client-server and multi-tier architectures, Web clients and Web servers, Application servers and middleware, introduction to cloud-based web deployment models. Hypertext Transfer Protocol, HTTP/1.1, HTTP/2 and overview of HTTP/3, HTTPS, WebSockets, WebRTC, Client-side programming with XHTML, HTML5, CSS3, Responsive Web design principles, Event-driven

programming with JavaScript, Server-side programming, request handling and routing, sessions and session tracking techniques, state management in web applications; Microservices architecture, REST based microservices, Web frameworks – MVC and component based frameworks, Applications and research trends.

Robert W. Sebesta, Programming the World Wide Web, 9th Edition, Pearson Education, 2018.
Paul Deitel and Harvey Deitel, Internet and World Wide Web How to Program, 6th Edition, Pearson Education, 2019.
Sam Newman, Building Microservices, 2nd Edition, O'Reilly Media, 2021.
Leonard Richardson, Mike Amundsen and Sam Ruby, RESTful Web APIs, O'Reilly Media, 2013.

IT305N THEORY OF COMPUTATION (2-0-0) 2

Introduction to Automata: various types of Automata, Regular Expressions. Proving their equivalence. Pumping lemma and its applications to prove languages are not regular, closure properties of regular languages, and minimisation of automata. Applications. Context-free grammars, pushdown automata (deterministic and nondeterministic). Pumping lemma for CFLs, proving that languages are not CFLs. Properties of CFLs. Applications. Introduction to Turing machines, language acceptance by Turing machines, Church-Turing hypothesis, Chomsky hierarchy, Decidability, Notion of reduction, Undecidable problems of Turing Machines-Halting Problem, etc. Class P, NP, NP-Hard & NP-Complete problems.

J.E. Hopcroft and J.D. Ullman. "Introduction to Automata Theory, Languages of Computations", Addison-Wesley, 2008.
Michael Sipser, "Introduction to the Theory of Computation", Books/Cole Thomson Learning, 2014.
D. C. Kozen, Automata and Computability, Addison-Wesley, 1994.
J. C. Martin, Introduction to Languages and the Theory of Computation, McGraw-Hill, 2002
H. R. Lewis and C. Papadimitriou, "Elements of Theory of Computation", Prentice-Hall, 2015.

IT275N INFORMATION SYSTEMS (3-0-0) 3

Introduction to Information Systems; Information Systems Development: Life Cycle, Management, Strategies, Construction Approaches; Systems Planning; Systems Analysis: Requirements, Tools for Business Process Modelling, Data Flow Diagram & Its Use, Data Modelling, Analysis Report; Systems Design: Acquisition Development, Construction Development, Systems Design Report; Systems Implementation; Systems Maintenance: Management, Post-Project Evaluation.

Shouhong Wang and Hai Wang, Information Systems Analysis and Design, Universal Publishers, 2012.
V. Rajaraman, Analysis and Design of Information Systems, 3rd Edition, PHI Learning, 2011. Dennis, Wixom and Roth, Systems Analysis & Design, 5th Edition, John Wiley, 2012.
Langer A.M, Analysis and Design of Information Systems, 3rd Edition, Springer, 2008. James A. Senn, Analysis & Design of Information Systems, 2nd Edition, McGraw-Hill, 2008.
Jeffrey L. Whitten and Lonnie D. Bentley, System Analysis and Design Methods, 7th Ed., McGraw-Hill, 2007.
Raul Sidnei Wazlawick, Object Oriented Analysis and Design for Information Systems: Modelling with UML, OCL, and IFML, Elsevier, 2014.

IT276N PARADIGMS OF PROGRAMMING (3-0-0) 3

Programming domains; Language Evaluation; Programming Paradigms – Imperative, Functional, OOP and Logic programming; Formal methods: syntax and semantics - Backus Naur Form, Attribute grammars; Describing semantics - Denotational semantics; Data types, Names, Variables, Bindings, Scope and lifetime, Referencing Environments; Named Constants-Variable Initialization-Subprograms-Parameter Passing – Coroutines; Even Driven Programming: Fundamentals; Case studies from Desktop to Mobile applications, VB.NET, ANDRIOD Applications; Functional programming languages - Lambda calculus - LISP; Application of functional programming languages; Logic programming languages –introduction to predicate calculus - Horn

clauses - Logic programming: Prolog, Applications; Asynchronous Programming Model with a Case Study (AJAX, C#...); Run-time Program Management; Virtual Machines: Java Virtual Machine, Common Language Infrastructure, Late Binding of Machine Code, Just-in-Time and Dynamic Compilation, Binary Translation, Binary Rewriting, Mobile Code and Sandboxing, Performance Analysis.

Robert W. Sebesta, Concepts of Programming Languages, 11th Edition, Pearson, 2016.
Ravi Sethi, Programming Languages - Concepts and Constructs, 2nd Edition, Pearson, 2002. Michael L. Scott, Programming Language Pragmatics, 4th Edition, Morgan Kaufmann, 2015.
Kenneth.C. Louden, Programming Languages: Principles and Practices, 3rd Edition, Cengage Learning, 2011.

IT277N COMPUTER GRAPHICS (3-0-0) 3

Computer Graphics Hardware; Scan Conversion: lines, circles, ellipses; Filling Algorithms, Clipping 2D and 3D Algorithms, Viewing in 3D: Projections, 2D & 3D transformations, Visible surface determination, Animation of 2D images: Implementation of 2D packages which support graphics editors with classical input techniques and animation.

Hearn and Backer, Computer Graphics Principles and Practice-3rd Edition, Addison Wesley, 2013.
Van Dam, Foley, Feimer, Hugher Computer Graphics Principles and Practice in C, 1st ed., Pearson, 2013.

IT278N MICROPROCESSORS AND INTERFACING (3-0-0) 3

Microprocessor history, Microprocessor architecture, 80x86, instruction set, subroutines, Programming examples, software development systems, Interrupts, Polling, Daisy chain, RST instructions, Priority encoder, Programmable peripheral devices, 8255, 8253, 8259, 8257, Intel 80386, 80486 & Pentium Processors, Motorola 68000, 68020, 68030 processors, Mother boards, I/o bus, I/O channel, BIOS, DOS PC bus, Multibus I& II, VME and peripheral controllers.

Douglas V. Hall, Microprocessors and Interfacing, 2nd Edition, Tata McGraw-Hill, 2006.
Babby B. Brey, The Intel Microprocessors – Architecture, Programming & Interfacing, Pearson/Prentice Hall, 2008

IT279N PERFORMANCE MODELLING (3-0-0) 3

Performance Evaluation methods. Analytical versus simulation Modelling. Performance measurement and benchmarking. Workload Modelling. Random variables. Commonly used distributions. Stochastic processes. Markov chain models of computer systems. Queuing models. Discrete event simulation. Simulation Languages. Confidence intervals. Variance reduction techniques. Case studies of analytical & simulation of computer systems.

Raj Jain, The Art of Computer Systems Performance Analysis, Jon Wisely and Sons, New York, USA, 1991.
KS Trivedi, Probability and Statistics with Reliability, Queuing and computer science, PHI 1982.
Paul & Howard, Computer systems performance Evaluation & Prediction, Elsevier, 2005

IT280N MATHEMATICAL FOUNDATIONS FOR IT (3-0-0) 3

Number Theory Foundations: Divisibility, Primes, Euclidean Algorithm, Modular Arithmetic and Congruences, Fermat's Little Theorem, Euler's Theorem, Chinese Remainder Theorem, Quadratic Reciprocity. Algebraic Structures and Coding Theory: Groups, Subgroups, Cyclic Groups, Rings and Integral Domains, Fields and Finite Fields, Polynomial Rings, Linear Block Codes, Generator and Parity-Check Matrices, Hamming Codes, Cyclic Codes, Reed–Solomon Codes, Error Detection and Correction. Optimization Techniques: Linear Programming (LP), Formulation of LP Problems, Graphical Method, Simplex Algorithm, Duality Theory. Nonlinear Optimization: Unconstrained Optimization, Lagrange Multipliers, Karush–Kuhn–Tucker (KKT) Conditions. Random Processes and Stochastic Modelling: Markov Chains, Poisson Processes, Birth–Death Processes, Stationary Processes, Queueing Theory, Reliability Models, Monte Carlo Simulation

Ross, Sheldon M. Introduction to Probability Models — Elsevier / Academic Press, 12th Edition (2019)
Hoffstein, Jeffrey; Pipher, Jill; Silverman, Joseph H. An Introduction to Mathematical Cryptography — Springer, 2014 (2nd Edition).
Boyd, Stephen; Vandenberghe, Lieven- Convex Optimization — Cambridge University Press, 2004
Pless, Vera, Introduction to the Theory of Error-Correcting Codes — John Wiley & Sons,3rd Edition (1998)
Neal Koblitz, A Course in Number Theory and Cryptography, Springer, 2nd Edition, 1994

IT281N EMBEDDED SYSTEMS (3-0-0) 3

Embedded System Design Process: Embedded Computing Platform, Program Design and Analysis, Real Time Operating Systems, Networks: Distributed Embedded Architecture, System on Chip (SOC) and the current trends. Embedded Hardware Platforms: Microcontrollers (Arduino, ESP32), Microprocessors (Raspberry Pi), Reconfigurable Hardware (FPGA), and ARM Processor Architecture, Introduction to Hardware Description Language.

David E Silmon, An Embedded Software Printer Pearson Edition Asia, 2001
Wayne Wolf, Computer as Components Harcort India Pvt. Ltd. 2001

IT282N BIOINFORMATICS (3-0-0) 3

Introduction to Bioinformatics, Biological Databanks, Biological Sequence Analysis: Genome- Microarray, pairwise sequence alignment, Dynamic programming, global and local alignment, Progressive multiple sequence alignment, Iterative multiple sequence alignment. BLAST Scoring matrices, gap penalty, statistical significance of multiple sequence alignment, sum-of-pairs method, CLUSTAL W, searching motifs in sequence alignment. Structure Prediction -Protein Secondary Class prediction, Protein Folding. Protein-Protein Interaction, Protein Subcellular Localization, Emerging Areas in Bioinformatics.

Durbin, R., Eddy, S., Krough, A. & Mitchison, G. Biological sequence analysis: probabilistic models of proteins and nucleic acids. Cambridge University Press, 1998
Jones, N.C. & Pevzner, P.A. An introduction to bioinformatics algorithms. MIT Press, 2004
Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press, 2001
Developing Bioinformatics Computer Skills by C. Gibas and P. Jam beck, 0' Reilly (2001)
Biological Sequence Analysis: Probabilistic models of proteins and nucleic acids by R. Durbin, S. Eddy, A. Krogh and
G. Mitchison, Cambridge University Press (1998)

IT283N KNOWLEDGE MANAGEMENT (3-0-0) 3

Introduction to knowledge management, Types of Knowledge within an organization. Intellectual capital. KM Architecture and Tools. ERP for KM. Knowledge sharing tools. Data ware housing, Knowledge strategy creation. KM practice. KM Process. Integrating knowledge sharing and learning, The chief knowledge Officer (CKO) and his/her job. Training programmes for organization. widelearing. Making KM work across various segments of industry and business firms. Case studies of KM practices in successful companies, Future challenges in KM.

Ratnja Gogula, Knowledge management: A New Dawn, Institute of Chartered Financial Analysts of India, 2002.

IT284N COMPETITIVE PROGRAMMING (3-0-0) 3

Solving problems using computers. Competitive Programming with time and memory constraints for the problems using various design techniques: Divide and conquer, Greedy, Dynamic Programming, Branch and bound, Backtracking, etc. The problems from the domain: Graph Problems, Combinatorial problems, Number theoretic problems, Game theoretic problems, String processing problems, Geometric problems, Numerical

problems, etc.

Steven S. Skiena, Miguel A. Revilla, Programming Challenges: The Programming Contest Training Manual, Springer-Verlag New York, 2003

Steven Halim, Felix Halim, Suhendry Effendy, Competitive Programming 4 – Book 2: The Lower Bound of Programming Contests in the 2020s, Lulu Press,2020

Laaksonen, A. Guide to competitive programming: Learning and improving algorithms through contests. Springer, 2024.

IT350N SOFT COMPUTING (3-0-0) 3

Optimization and Some Traditional Methods and issues, Introduction to Genetic Algorithms, Some Specialized Genetic Algorithms, Introduction to Fuzzy Sets, Fuzzy Reasoning and Clustering, Fundamentals of Neural Networks, Fundamentals biologically inspired computing, Hybrid soft computing methods, Swarm optimization techniques: Particle swarm optimization and Global swarm optimization, Applications and Recent Research Trends.

Vojislav Kecman, Learning and Soft Computing, Pearson Education (Asia) PTE, 2004 Ross T.J., Fuzzy logic with engineering applications-McGraw Hill, 1995

J. M. Zurada, Introduction to artificial neural networks, Jaico publishing, 1997. Goldberg D., Genetic algorithms-Addison-Wesley, 1st edition,1989.

S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing 2nd edition, Wiley, 2011.

Shishir K. Shandilya, Smita Shandilya, Kusum Deep, Atulya K. Nagar, Handbook of Research on Soft Computing and Nature-Inspired Algorithms, IGI Global, 2017.

Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer)

J. Han and M. Kambar, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers (Elsevier), 2008

IT351N GENETIC ALGORITHMS (3-0-0) 3

Robustness of traditional optimization and search techniques, Simple Genetic Algorithms, Similarity templates, goals of optimization, Schema Theorem of John Holland, Computer Implementation and Applications of genetic algorithms, advanced operators and techniques in genetic algorithms, Recent research Trends.

David Goldberg, Genetic Algorithms in search, optimizations and machine learning, Addition Wesley, 1999 Charles L Karr and L Michael Freeman, Industrial applications of Genetic Algorithms, CRC Press 1998.

IT352N ARTIFICIAL NEURAL NETWORKS (3-0-0) 3

Introduction to Artificial Neural Networks, Artificial Neuron Model and Linear Regression, Gradient Descent Algorithm, Nonlinear Activation Units and Learning Mechanisms, Learning Mechanisms, Associative Memory

Model, Statistical Aspects of Learning, Single-Layer Perceptron, Least Mean Squares Algorithm, Perceptron Convergence Theorem, Bayes Classifier, Back Propagation Algorithm, Multi-Class Classification Using Multi-layered Perceptrons, Radial Basis Function Network, Introduction to Principal Component Analysis and Independent Component Analysis, Introduction to Self-Organizing Maps, Applications and Recent Research Trends

Simon Haykin, Neural Networks - A Comprehensive Foundations, Pearson, 2004

Laurene Fausett: Fundamentals of Neural Networks: Architectures, Algorithms & Apps., Pearson, 2004. James A. Anderson, An Introduction to Neural Networks, MIT press, 1995.

Yegnanarayana: Artificial Neural Networks, Prentice Hall of India,2004.

IT353N FUZZY SYSTEM MODELS (3-0-0) 3

Classical /crisp set, fuzzy sets, Fuzzy numbers, Fuzzy arithmetic, Fuzzy measures, Operations on Fuzzy sets, Fuzzy relations, Multi valued logic, Fuzzy logic, Uncertainty and information, Approximate reasoning, Fuzzy decision making, Fuzzy models, case studies.

Klir and Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India 2001.
Li Xin Wang, A Course in Fuzzy Systems and Control, Prentice Hall, 1996.
J. Yen and R. Langari, Fuzzy logic: Intelligence, Control and Information, Pearson, 1998.

IT354N DATA WAREHOUSING AND DATA MINING (3-0-0) 3

Introduction to data mining: Data pre-processing, Data warehouse and OLAP technology, Data cube computation and data generalization, Mining frequent patterns, associations and correlations, Classification and prediction, Cluster analysis, Data mining on complex data and applications, Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.

Han, J. and Kamber, M., Data Mining - Concepts and Techniques, 3rd Ed., Morgan Kaufmann Series, 2008.
Alex Berson, S. J. Smith, Data Warehousing, Data Mining & OLAP, McGraw Hill
Tan, P.N., Steinbach, M. and Kumar, V., Introduction to Data Mining, Addison Wesley – Pearson, 2006 Pujari, A. K., Data Mining Techniques, 4th Ed., Sangam Books.
Oded Maimon, Lior Rokach, The Data Mining and Knowledge Discovery Handbook, Springer, 2005.
S. Weiss and N. Indurkhya, Predictive Data-Mining: A Practical Guide, Morgan Kaufmann, 1998.
S. Weiss, N. Indurkhya, T. Zhang and F. Damerau, Text Mining: Predictive Methods for Analyzing Unstructured Information, Springer, 2004.

IT355N MIDDLEWARE TECHNOLOGIES (3-0-0) 3

Introduction to Middleware Technologies, General Middleware, Service Specific Middleware, Client/Server Building blocks: RPC, Messaging – P2P, Java RMI, Computing standards, OMG, Introduction to CORBA, EJB and .NET, XML Technologies - XML, DTD, XSD, XSLT, XQUERY, XPATH, Web Services and SOA.

G. Sudha Sadasivam, Distributed Component Architecture, Wiley India Edition.
Thomas Erl, Service Oriented Architecture: Concepts, Technology & Design, Prentice Hall
G. Brose, A Vogel and K. Duddy, Java programming with CORBA, 3rd Edition, Wiley India Joha Wiley and Sons Ed Roman, Mastering Enterprise Java Beans, John Wiley & Sons Inc.

IT356N TECHNOLOGIES FOR INTERNET OF THINGS (3-0-0) 3

Principles and foundation of IoT: Reference Models, Platforms, Big data and IoT, Relevance of AI in IoT. IPv6 packet. Communication standards for IoT: IEEE 802.15.4, IEEE 802.11, 6LoWPAN. Routing in IoT, Standards for IoT, 5G. Service Oriented architecture, The Constrained Application Protocol (CoAP) and MQTT: features, interaction model, messages and request and response sub layer. Application of AI in IoT. Design of IoT for Smart Applications.

Amita Kapoor, Hands on Artificial Intelligence for IoT, Packet, 2019
J. Biron and J. Follett, Foundational Elements of an IoT Solution, O'Reilly Media, 2016. Keysight Technologies, The Internet of Things: Enabling Technologies and Solutions for Design and Test, Application Note, 2016.
Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, Apress, 2013 Arshdeep Bahga and Vijay Madisetti, Internet of Things: A hands on approach, VPT Publications 2014
Olivier Hersent, David Boswarthick, Omar Elloumi, The IoT: Key Applications and Protocols, Wiley, 2015.

IT357N WIRELESS SENSOR NETWORKS (3-0-0) 3

Introduction to wireless communication and wireless sensor networks, Network architecture and design principles, MAC and link layer protocols, Topology control in WSN, Routing protocols, Information Aggregation, Information Storage, Query, Localization, Security issues, Applications and recent trends: Wireless multimedia sensor networks.

F. Zhao and L. Guibas, Wireless sensor networks: An information Processing Approach, Morgan-Kaufmann, 2004. Carlos de Morais Ciordeiro and Dharma Prakash Agrawal, Adhoc and Sensor Networks: Theory and Applications, World Scientific Publications, 2006.

IT358N MOBILE ADHOC NETWORKS (3-0-0) 3

Mobile ad hoc networking; imperatives, challenges and characteristics, Bluetooth networks, Routing approaches, Proactive and reactive protocols. Clustering and hierarchical routing, Multipath routing, Security aware routing, Energy efficient communication in Mobile ad hoc networks, Measuring energy consumption, Power save protocols, Maximum life time routing, Secure routing protocols, Intrusion detection, Security considerations in ad hoc sensor networks, Key management, Characterization of IP traffic, QOS classification, Self similar processes, Statistical analysis of both non – real time traffic and real – time services.

C.S. Murthy & B.S. Manoj, AdHoc Wireless Networks, Pearson, 2006.
Reddy, G. Ram Mohana, and Kiran M., Mobile Ad Hoc Networks: Bio-Inspired Quality of Service Aware Routing Protocols. CRC Press, Boca Raton, 2016.
T.Janevski, Traffic Analysis and Design of Wireless IP Networks, Artech House, 2003. Ozan K. Tonguz & Gianluigi, Adhoc Wireless Networks, Wiley, 2006.

IT359N SEMANTIC WEB TECHNOLOGIES (3-0-0) 3

Introduction to the Semantic Web – What is Semantics; Syntax, Structure and Semantics, Layered Cake Architecture; Structured Web Documents and Resource Description Framework – Understanding content, Metadata, metadata standards, XML + metadata specification, RDF and metadata processing; Programming with RDF/XML; Web Ontology Language (OWL)- Domain Modelling, Logic, Inferencing, Context; Logic Reasoning for the Semantic Web- Classification and semantic metadata extraction techniques: statistical, statistical learning/AI, lexical and natural language, knowledge based; Programming with Ontologies; Semantic Applications- semantic technology for services, search, personalization, contextual/custom/ enterprise applications; Linked Open data and next generation semantic content management; Research trends and open issues.

Pascal Hitzler et al, Foundations of Semantic Web Technologies, Chapman & Hall, 2009. Karin Breitman et al, Semantic Web: Concepts, Technologies and Applications, Springer, 2010.
Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, The MIT Press, 2nd Edition, 2008. John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, Semantic Web Programming, Wiley, 2009.

IT360N VIRTUAL REALITY (3-0-0) 3

Introduction to Virtual Reality Technology and its effectiveness in Real -Time Applications, Scientific Visualization, Input Devices: Trackers, Navigation and Gesture Interfaces; Output Devices: Graphics, 3D Sound and Haptic Displays; Computing Architectures for Virtual Reality, Modelling, Virtual Reality Programming, Human Factors in Virtual Reality; Overview of Virtual Humans, Face Cloning & Face Motion Capture/Analysis and Research Trends. Gerard Jounghyun Kim, Designing Virtual Reality Systems – The Structured Approach, Springer-Verlag, 2005.

N Magnenat-Thalmann and D Thalmann, Handbook of Virtual Humans, Wiley, 2004.
L.J. Hettinger, M W. Haas, Virtual & Adaptive Environment: Apps, Human Performance, Lawrence Erlbaum, 2003. Grigore C Burdea and Phillippe Coiffet, Virtual Reality Technology, John Wiley, 2003.

IT361N WEB SERVICES (3-0-0) 3

IT Architecture, Distributed Information Systems, Middleware and Enterprise Application Integration, Introduction to Service Oriented Architecture, Web Services origins, standards, basic concepts, Web Service Technologies and Architecture; protocols for Web service Description, Discovery and Access (WSDL, UDDI and SOAP); Web Service Application Management: Co-ordination, Service Orchestration and Compositions; Web Service Application Development: developing Web services, exposing functions as web methods, accessing service endpoints, WCF Framework; RESTful Web Services - basics, concepts, Restful application development and deployment; Services for the Internet of Things - Constrained Application Protocol (CoAP), features, interaction model; Semantic Web Services - background, motivation, advantages, basic concepts; Research Trends and open problems.

Alonso G, Casati F, Web Services - Concepts, Architectures and Application Series: Data-Centric Systems and Applications, Springer, 2011
Robert Daignea, Service Design Patterns: Fundamental Design Solutions for SOAP/WSDL and RESTful Web Services 1st Edition, Addison Wesley Professional, 2011
Sam Newman, Building Microservices: Designing Fine-Grained Systems, O-Reilly, 2015
Thomas Erl, Service-Oriented Architecture: Concepts, Technology, and Design, Prentice Hall, 2005.

IT362N SOFTWARE ARCHITECTURE (3-0-0) 3

Definition and overview of software architecture, The architecture business cycle: what influences software architects, Different Architectural styles, Architecture description language, Understanding and achieving quality attributes, Attribute-driven design, Documenting/Evaluating Software Architecture and its reuse, Case studies and Recent Trends.

Mary Shaw, David Garlan, Software Architecture, Prentice Hall, India, 2000
Bass, Len; Paul Clements, Rick Kazman, Software Architecture In Practice, Second Edition. Addison-Wesley, 2003.
Clements, Paul et al, Documenting Software Architectures: Views and Beyond. Addison-Wesley, 2003.

IT363N SOFTWARE QUALITY ASSURANCE (3-0-0) 3

Overview of Software Engineering. Requirement Engineering Analysis, software reliability. Definition and concepts of software reliability, software quality. Introduction to software quality principles, total quality management, Quality Assurance Standards. ISO 9000 Tick-It method. Miscellaneous Issues: Software maintenance. Future OF SQA

John J. Marciniak, Encyclopedia of Software Engineering. - Vol. I & II. John Wiley & Sons, 1994. Ince Darrel. ISO 9001 and Software Quality Assurance. McGraw Hill, 1994
Pankaj Jalote, An Integrated Approach to Software Engineering Narosh Publications, 1995 Isabel Evans, Achieving software Quality through team work, Allied publishers, 2004.

IT364N LINUX KERNEL INTERNALS (3-0-0) 3

Introduction to the Kernel: Important data structures, task structure, process table, files and inodes, dynamic memory management, queues and semaphores, system time and timers, main algorithms, signals, interrupts, booting the system, timer interrupt, scheduler, implementing system calls. Memory Management: LINUX, virtual address space for a process, block device caching, paging under LINUX. Inter- Process Communication: Synchronization in the kernel, Communication via files, pipes, debugging using ptrace, IPC with sockets. The LINUX File System: Basic principles, representation of file systems in the kernel, Proc file system, Ext2 file system. Device drivers under LINUX: Character and block devices, Polling and interrupts, Implementing a driver, Multi-processing: Intel multi-processor specification, problems with multi-processor

systems, changes to the kernel, kernel initialization, scheduling, message exchange between processors, entering kernel mode, Interrupt handling, compiling LINUX SMP.

Michael Beck et al., Linux Kernel Internals, Second Edition, Addison-Wesley, 1998. Michael Beck et al., Linux Kernel Programming, Third Edition, Addison-Wesley, 2002.

IT365N NUMBER THEORY AND CRYPTOGRAPHY (3-0-0) 3

Number Theory: Divisibility theory in the integers, Primes and their Distribution, The theory of congruences, Fermat's theorem, Number-theoretic functions, Euler's generalisation of Fermat's theorem, Primitive roots and indices, The quadratic reciprocity law. Review of abstract, Algebra – Groups, rings and fields. Primality Testing – Fermat test, Carmichael numbers, Solvay-Strassen Test, Miller-Rabin Test, etc. Classical Cryptosystems, Symmetric Key Cryptography, Public Key Cryptography, Various adversarial attacks and proof of security, Cryptographic Hash functions, Digital Signatures, Provable security, Key Exchange and Authentication, Identification Schemes, Commitment Scheme, Secret Sharing, Verifiable Electronic Elections, Elliptic Curve Cryptography, Various applications and protocols.

J. Katz and Y. Lindell, Introduction to Modern Cryptography, Third edition CRC press, 2020
Menezes Bernard, Network Security and Cryptography, 1st Edition, Cengage Learning India, 2010.
Neal Koblitz, Number theory and cryptography, Springer, 2007.
Hans Delfs, Helmut Knebl, Introduction to Cryptography: Principles and Applications, Springer
Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.
Stinson. D. Cryptography: Theory and Practice, 3rd edition, Chapman & Hall/CRC, 2012.

IT366N CYBER SECURITY (3-0-0) 3

Introduction, Types of Attacks, Digital Privacy, Online Tracking, Privacy Laws, Types of Computer Security risks, Antivirus Social Engineering, Secure online browsing, Secure WIFI settings, Cryptography and Secure Communication: Cryptographic Functions, Digital Signature, The Difference Between Digital Signatures and Electronic Signatures, Cryptographic Systems Trust Models, Create a Cryptographic Key Pair Using Gpg4win/gpg4usb, Disk Encryption Using Windows BitLocker, Disk Encryption Using Open Source Tools, Multitask Encryption Tools, Cloud storage security, IoT security, Physical Security Threads. Online Anonymity: Anonymous Networks, Tor Network, I2P Network, Freenet, Darknet, VPN, Proxy Server, Secure network protocols (SSL/TLS, SSH, IPsec), Encrypt DNS Traffic and Email communication, Secure IM and video calls. Anonymous OS, System security - Patch management and system hardening Cyber Crime Issues and Investigation: White collar Crimes, Viruses and Malicious Code, Internet Hacking and Cracking, Virus Attacks, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Digital laws and legislation, Law Enforcement Roles and Responses, Investigation Tools, eDiscovery, EDRM Model.

Nihad Hassan, Rami Hijazi, Digital Privacy and Security Using Windows: A Practical Guide Apress. Network Security Essentials, William Stallings, 4th Edition, Pearson Education, 2008.
Internet and Intranet Security, Rolf Oppliger, 2nd Edition, Artech House, 2007.
Applied Cryptography, Code Complete, Secure Programming, Articles and papers from http://securityresearch.in. Fundamental Problems in Provable Security and Cryptography, Alexander W. Dent (Research Paper).
Cryptography: An Introduction, Nigel Smart, 3rd Edition, Mcgraw-Hill, 2013.
Cryptography and Network Security, Behrouz A Forouzan/ Mukhopadhyay, 3rd Ed., McGraw-Hill, 2015.

IT367N DEEP LEARNING (3-0-0) 3

Deep Networks: Deep FeedForward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Neural Networks, Sequence Modelling - Recurrent and Recursive Nets, LSTM -

GRU, Autoencoders - Transfer learning, Transformers, Practical Methodology, Applications of Deep Learning, Deep Generative Models, Research Trends.

Josh Patterson and Adam Gibson, "Deep learning: A Practitioner's Approach", O'Reilly, 2017 Ian Goodfellow, Y. Bengio and A. Courville, "Deep Learning", MIT Press, 2016.
Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015 Li Deng and Dong Yu, "Deep Learning: Methods and Applications", 2013
Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009

IT368N SOFTWARE SYSTEM DESIGN (3-0-0) 3

Fundamentals of System Design, System Architecture & Design Patterns, Scalability & Load Management, Database Design in Large Systems, Distributed Systems Concepts, System Reliability & Monitoring, Security in System Design, Designing Real-World Systems.

Alex X u, Designing Data-Intensive Applications – Martin Kleppmann. System Design Interview

IT369N USER EXPERIENCE DESIGN (3-0-0) 3

UI/UX Overview: Intro to UI/UX,Finding bad UI/UX design; Design: Introduction,Design Toolkit and UI/UX Notebook;User Research:How to identify stakeholders, Defining stakeholders, How to identify user needs,Creating UX Flows,User Journeys:Mapping the user journey, Finding solutions & constraint cards, User Experience Design techniques such as scenarios, personas, storyboards, wireframing, and information architecture; UX Principles: Present Sketches, UX Principles, Converting Sketches to Grayscales, Psychology of UX; User Testing:Understanding user testing, Prepare grayscales USER EXPERIENCE for user testing, think aloud testing; UI Principles:layout and alignment, Finding good UI, color and text,Visual Design Specification;UI Components: buttons, icons, controls, prototyping.

Interaction Design: Beyond Human-Computer Interaction, by Rogers, Sharp, and Preece, ISBN-10 # 0470665769 The Design of Everyday Things, by Norman, ISBN-10 # 0465050654
Sketching User Experiences: Getting the Design Right and the Right Design, by Buxton, ISBN-10 # 0123740371 Designing for Small Screens: Mobile Phones, Smart Phones, PDAs, Pocket PCs, Navigation Systems, MP3 Players, Game Consoles, by Studio 7.5, Zwick, and Schmitz, ISBN-10 # 2940373078

IT370N MOBILE COMPUTING (3-0-0) 3

Evolution of Wireless and Cellular Systems; Wireless Propagation: Encoding, Modulation, Multiplexing, and Error handling Techniques; MAC Layer: channel allocation techniques; study of mobile communication systems: Infrastructure, Registration and basic call Establishment and Termination, Handoff, Roaming Support; Threat, Logical Migration, Mobile agents, Security issues. Smartphone-based platform architectures and applications, Smart Phone Based Software like android studio, etc, Development of Smart Phone based real time applications, future directions.

Raj Kamal, Mobile Computing, oxford university press 2017.
Joschen Schiller, Mobile communications, Pearson, 2003.
Pattnaik, P. K., and Mall, R., Fundamentals of Mobile Computing, PHI Learning, 2015.
Building Mobile Apps at Scale: 39 Engineering Challenges: GergelyOrosz 2021
William Stallings, Wireless Communication & Networks, Practice Hall of India,2nd Edition, 2004.

IT371N COMPILER DESIGN (3-0-0) 3

Introduction to compiler design, Model of a Compiler, Translators, Interpreters, Assemblers, Languages, Computer Architecture vs Compiler Design. Lexical analyzer, Regular expressions and finite automata. Introduction to context free grammars. BNF notation, Syntax Analysis. Parsing Techniques: Top-down parsing and Bottom-up parsing, general parsing strategies, brute force approach, recursive descent parser and

algorithms, simple LL (1) grammar, bottom-up parsing-handle of a right sentential form, shift reduce parsers, operator precedence parsers, LR, SLR, Canonical LR, LALR grammar and parsers, error recovery strategies for different parsing techniques. Symbol table, syntax-directed translation schemes, intermediate code generation, translation schemes for programming language constructs, runtime storage allocation. Code generation and instruction selection: Issues, basic blocks and flow graphs, register allocation, DAG representation of programs, code generation from DAG, peephole optimization, code generator generators, specifications of machine. Code optimization, source of optimizations, optimization of basic blocks, loops, global dataflow analysis, solution to iterative dataflow equations.

Alfred V. Aho, Monica Lam, Ravi Sethi & Jeffrey D. Ullman, Compilers: Principles, Techniques & Tools, Addison- Wesley Publication, 2006.
William A. Barrett, John D. Couch, Compiler Construction, Theory and Practice", Galgoria 2000.
Holub A.I., Compiler Design in C, Prentice Hall India, 2000.
Andrew W Appel, Modern Compiler Implementation in ML, Cambridge University Press, December 1997.

IT400N ADVANCED COMPUTER NETWORKS (3-0-0) 3

Review of TCP/IP Protocol suit with latest developments, Broadband networks, advanced concepts: ATM,

Frame Relay, Fiber Optic Networks: SONET, VOIP, MIPv6 etc., Remote Access and Wireless Networking: Virtual Private Networks - L2 and L3 Switches, Tunneling; BGP and Adaptive Routing, MPLS: QoS, Network Recovery/Restoration; Security Issues in TCP/IP and BGP, DoS/DDoS attacks, Mitigation with recent trends, Network Management issues and protocols, Internet Management, Common Management Information services/protocol (CMIS/CMIP), Network Trouble Shooting, QoS (Integrated/Differentiated Services), Port based Network Access control, Availability, Scalability, Load Balancing and Recent Trends.

James F Kurose and Keith W Rose, Computer Networking, Pearson Education, 2003 Andrew. S. Tannenbaum, Computer Networks, Prentice Hall of India, 2nd Edition, 2002. M. Subramanian, Network Management: Principles and Practice, Addison- Wesley, 2000. William Stallings, Data and Computer Communications and Networking, 2nd Edition, TMH, 2002. Behrouz A Forouzan, Data Communications and Networking, 2nd edition, TMH, 2002. Leon, Garcia and Widjaja - Communication Networks, TMH 2002.

IT401N PERCEPTUAL AUDIO PROCESSING (3-0-0) 3

Fundamentals of Audio and Speech Processing; Speech and Audio Analysis: Transforms – STFT, DCT; Audio and Speech Compression Standards: MPEG and AAC; Human Auditory Perception; Perceptual Audio Quality Metrics, Perceptual Processing of Digital Speech; Speech and Audio Rendering; Speech and Audio Storage and Retrieval; Applications and Research Trends.

Jacob Benesty, M. Mohan Sondhi and Yiteng Huang, Handbook of Speech Processing, Springer-Verlag, 2008. A Spanias, T Painter and Venkatraman A, Audio Signal Processing and Coding, Wiley-Interscience, 2007. Hugo Fastl and Eberhard Zwicker, Psychoacoustics: Facts and Models, Springer, 3rd edition, 2006. Marina Bosi and Richard E. Goldberg, Introduction to Digital Audio Coding Standards, Springer, 2002.
Ben G, Nelson M, Speech & Audio Signal Processing: Processing/Perception of Speech/Music, Wiley, 1999.

IT402N PERCEPTUAL VIDEO PROCESSING (3-0-0) 3

Fundamentals of Image and Video Processing; Image and Video Analysis: Image Transforms - DCT, Hadamard,

Haar, KL and Wavelets; Image and Video Compression Standards: JPEG, JPEG2000, MPEG1, MPEG2, MPEG4 & MPEG7; Image and Video Rendering and Assessment; Human Visual Perception; Perceptual Video Quality Metrics, Perceptual Coding and Processing of Digital Pictures; Image and Video Storage, Retrieval; Applications and Research Trends.

Perceptual Based Image Processing, Morgan & Claypool, 2009
Al Bovik, Handbook of Image and Video Processing, Elsevier Academic Press, 2005
H. R. Wu and K. R. Rao, Digital Video Image Quality and Perceptual Coding, CRC Press, 2005
R. C. Gonzalez and R E Woods, Digital Image Processing, Pearson Education, 2002 William K Pratt, Digital Image Processing, Wiley, 2001.

IT403N COMPUTER VISION (3-0-0) 3

Introduction to Computer Vision, Color + Math basics, Pixels and filters, Edge detection, Features and fitting, Feature descriptors, Resizing, Semantic segmentation, Clustering, Object recognition, Face identification, Visual Bag of Words, Detecting objects by parts, Image classification, Motion Tracking, Introduction to Deep Learning.

Sonka M., Hlavac V., Boyle R., Image Processing Analysis and Machine Design. PWS Publishers Ballard D., Brown C., Computer Vision, Prentice Hall, 1982.
R. C. Gonzalez and R. E. Woods, Digital Image Processing, Addison Wesley, 1992.

IT404N PATTERN RECOGNITION (3-0-0) 3

Patterns/features. Pattern recognition approaches. Discriminant functions. Statistical pattern recognition, Gaussian model. Parametric estimation. Bayesian parameter estimation, pattern classification by distance functions Cluster analysis, Syntactics pattern recognition. Features extraction and recent advances.

Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall 1999.
Duda RO and Hart PE, Pattern Classification and Scene Analysis, Wiley 1973.

IT405N INFORMATION TECHNOLOGY FOR HEALTHCARE (3-0-0) 3

Evolution of IT Enhanced Healthcare, Internet Technologies in Telemedical Systems, Wireless Systems in - Health, Decision Support Systems in Medicine, Health Telematics Networks, Computer Aided Diagnosis and Recent Trends. Krzysztof Zielinski, Mariusz Duplaga and David Ingram, IT Solutions For Healthcare, Springer, 2006

Robert E Hoyt, Nora Bailey, Ann Yoshihashi, Health Informatics, 5th Edition, Lulu Publishers, 2012 Kevin Beaver, Healthcare Information Systems, Auerbach Publications, 2nd Edition, 2002.

IT406N NATURAL LANGUAGE PROCESSING (3-0-0) 3

Introduction to linguistics and levels of language analysis. Building blocks of language, Challenges in NLP. Text preprocessing: tokenization, normalization and stemming. N gram models. Syntactic and semantic analysis: POS tagging, information extraction, named entity recognition, relation extraction and parsing techniques. Probabilistic models, HMM and Maximum Entropy. Semantic analysis, word sense disambiguation, semantic similarity, WordNet and topic Modelling. Distributional semantics and neural language models. Word and sentence embeddings, Word2Vec, GloVe, FastText, Contextualized embeddings: BERT and its variants. NLP pipelines and deployment. Large Language Models, NLP applications: text classification, sentiment analysis, text summarization, machine translation, chatbots, dialog systems, question answering. NLP in healthcare, education and multimodal systems. Emerging research trends.

Daniel Jurafsky and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Prentice Hall 2000.
Christopher D. Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing MIT Press, 1999.
James Allen, Natural Language Understanding. Benjamin/Cummings, 2ed, 1995.
Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, Released June 2020, Publisher(s): O'Reilly Media, Inc.

IT407N INFORMATION RETRIEVAL (3-0-0) 3

Introduction: Basic Concepts, Information need vs. Query, Modern Search Interface requirements, IR System Architecture, Classic IR Models for unstructured text, preprocessing techniques, Tokenizing, Indexing, and Implementation of IR models, Structured IR models, Multimedia IR, Experimental Evaluation of IR Systems, Implicit and Explicit Relevance Feedback techniques, Document/Query Properties and Representations, Web Search and Link analysis algorithms, Recommender Systems, Learning to Rank and Learning the ranking function based techniques, Machine learning in IR, Selected research papers on emerging trends and open problems in IR.

C. D. Manning et al., Introduction to Information Retrieval, Cambridge University Press. 2008. Baeza-Yates & Ribeiro-Neto, Modern Information Retrieval, Pearson Education, 2010
Donald Metzler et al., Search Engines: Information Retrieval in Practice, Pearson Education, 2010

IT408N ADVANCED DATABASE SYSTEMS (3-0-0) 3

Design of database kernels, Schema integration, Data warehousing, Distributed database design, Distributed query processing, Distributed transaction processing, Object-Relational databases, Emerging database technologies and applications, Application of conceptual and physical design to the real-world database problems, Research Trends.

M. Tamer Özsu, Principles of Distributed Database Systems, Prentice Hall, 2011.
Ceri S and Pelagatti G, Distributed Databases: Principles and Systems, McGraw-Hill, 2009.
T Connolly and C Begg, Database Systems: A Practical Approach to Design, Implementation and Management, Pearson, 2015.
R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, Addison-Wesley, 3rd ed., 2011.
R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw-Hill, 3rd ed., 2014.
M. Stonebraker and J. Hellerstein, Readings in Database Systems, Morgan Kaufmann, 4th ed., 2005.
M. Stonebraker, Dorothy Moore, Object-Relational DBMSs, Morgan Kaufmann, 2nd ed., 1998.
J. Han, M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, 3rd ed., 2012.

IT409N CRYPTOCURRENCIES AND BLOCKCHAIN TECHNOLOGIES (3-0-0) 3

Fundamentals of Blockchain, peer-to-peer network, Types of Blockchain: Ethereum, Hyperledger, basics for cryptocurrency, Cryptographic hash functions, signature schemes, Blocks, Merkley Tree transaction verifiability, Smart Contracts, Consensus Algorithms, anonymity, forks, double spending, DAPP, Cross Chain Applications, Redaction in Blockchain, Bidirectional Blockchain, Applications of Blockchain: Health care, Insurance, IoT etc.,

Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and privacy, 2015
J. A. Garay et al, the bitcoin backbone protocol – analysis and applications EUROCRYPT 2015 LNCS VOl 9057. (VOLII), pp 281-310. serious beginning of discussions related to formal models for bitcoin protocols.
R. Pass et al, Analysis of Blockchain Protocol in Asynchronous networks, EUROCRYPT 2017. A significant progress and consolidation of several principles. 4. R. Pass et al, Fruitchain, a fair blockchain, PODC 2017.

IT410N ROBOTIC PROCESS AUTOMATION (3-0-0) 3

RPA Basics – History of Automation – What is RPA – RPA vs Automation – Programming Constructs in RPA – What Processes can be Automated – Types of Bots – Workloads which can be automated; Process Models and Process Discovery, Different Types of Process Models, Process Discovery Techniques and Conformance

Checking – RPA Development Methodologies - Determining and Designing Automation Process – -Generating RPA Analytics; Develop

bots to accomplish the common business scenarios like : Capturing user interactions using appropriate Recorders, Running bots from the Workbench and the Control Room, Creating a Meta bot to handle an application login, Integrating with common desktop applications, Writing data from a text file to an Excel spreadsheet, Copying spreadsheet data to a Windows application, Hardening bots against common exceptions, Debugging bots using the debugging feature, Extracting data from web pages, sending and receiving emails, Downloading email attachments, Extracting data from Adobe PDFs, Calling REST web services, Error handling.

Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release Date: March 2018 ISBN: 9781788470940
The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems; Tom Taulli; Apress, 2020 ISBN 1484257286, 9781484257289.

IT411N QUANTUM COMPUTING (3-0-0) 3

History of quantum computation and quantum information, Future directions, Basic Mathematics: Linear operators and matrices, Tensor products, Operator functions. Quantum Logics: QISKIT, Introduction to Qubit, Single qubit operation, Multiple Qubit operation, Single qubit gates, Multiple qubit Gates, Controlled Not gate, Swap gate, Toffoli gate, Universal quantum gates. Quantum Algorithms and Applications: The quantum search algorithm, Quantum search as a quantum simulation, Quantum counting, Speeding up the solution of NP complete problem, Quantum search of an unstructured database, Optimality of the search algorithm.

Michael. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum information, Cambridge University Press 2000.
Bellac Michel Le, A short introduction to quantum information and quantum computation, Cambridge University Press, 2006
Vishal Sahni, Quantum Computing, Tata McGrawHill, 2007.
Richard L. Liboff, Introductory Quantum Mechanics, Pearson, Fourth Edition (2003). QISKIT textbook

IT412N LARGE LANGUAGE MODELS (3-0-0) 3

Introduction to Language Model - Transformers - BERT - LLM foundation; AI Safety Primer and Representation Engineering; Deep Learning Frameworks Design Principles - Pre-trained LLMs - Tokenization and Decoding; Model Quantization and Compression; Prompt tuning - Efficient fine-tuning of LLMs - LoRA - QLoRA; Memory Optimization for LLMs; Retrieval-augmented Language Models; Multimodal LLMs; Security of LLMs. Evaluation of LLM. Applications and new trends in LLM.

Raschka, Sebastian. Build A Large Language Model (From Scratch). Manning, 2024. ISBN: 978-1633437166.
Jay Alammar, & Maarten Grootendorst (2024). Hands-On Large Language Models. O'; Reilly.
Chakraborty, T. (2024). Introduction to Large Language Models: Generative AI for Text. Wiley.

IT413N APPLIED ALGORITHMS (3-0-0) 3

Sequential algorithms. Preliminaries: Algorithmic design techniques and representative problems. Combinatorial algorithms. Graph algorithms. String matching algorithms, External memory algorithms, online algorithms, algebraic and number theoretic algorithms and Security & Cryptography algorithms. Several other categories of algorithms. Design and analysis of Parallel algorithms, Problem reduction. Basics of randomized algorithms, and randomized algorithms, application of randomness for correctness verification. Hardness and basics of Approximation algorithms.

Alfred V Aho, john E Hopcroft, Jeffery D Ullman, Data structure and algorithms, Addison Wesley, 1993 (2)
J. Kleinberg, E. Tardos, Algorithm design. Pearson Education, Addison Wesley, 2006."

Michael Jay Quinn, Designing efficient algorithms for parallel computers, McGraw Hill 1997. Rajeev Motwani, PrabhakarRaghavan, Randomized algorithms, Cambridge University Press, 1995
R. E. Tarjan, Data structures and network algorithms, SIAM, 1983. Vijay V. Vazirani, Approximation algorithms, Springer, 2001.

IT414N RANDOMIZED ALGORITHMS (3-0-0) 3

Randomness and algorithms. Deterministic vs Randomized algorithms. Monte Carlo and Las-Vegas algorithms. Advantages of Randomized algorithms. Basic principles for the construction of randomized algorithms. Motivation: Game Tree Evaluation. Tools and Techniques; Basic probability theory; randomized complexity theory; game-theoretic techniques, etc. Randomized algorithms for the problems in various domains viz., Graph algorithms, Geometric algorithms, parallel and distributing algorithms, online algorithms, Number theory and algebra. etc., coupon collection and occupancy problems; Markov chains and random walks; stable distributions; probability amplification and derandomization. Applications: Sorting and searching; data structures; combinatorial optimization and graph algorithms; metric embeddings; online and streaming algorithms; algorithms for massive data sets including similarity search, nearest neighbours, and clustering; number- theoretic algorithms.

Motwani and Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
Mitzenmacher and Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press, 1995.
William Feller, An Introduction to Probability Theory and Its Applications, Volumes I and II, John Wiley, New York, 1968.
J. Hromkovic, Design and Analysis of Randomized Algorithms, Springer 2005.

IT415N APPROXIMATION ALGORITHMS (3-0-0) 3

Basics and definitions related to Approximation Algorithms; Greedy Algorithms (Set cover and Vertex Cover); Combinatorial Algorithms (Traveling Salesman Problem and Steiner Tree); Dynamic Programming and Rounding (Knapsack and Bin Packing); LP-based Algorithms: Randomized and Deterministic Rounding, Dual-Fitting, Primal-Dual Schema; Cuts and Metrics (Multicut, Multiway Cut, Max Cut, Sparsest Cut); SDP (Max Cut and Coloring); Geometric Approximation Algorithms (Geometric Set Cover, Hitting Set, Independent Set of Rectangles): Greedy, Shifted-Grid, Quad-Trees, Geometric Separators, Local Search; Sum of Squares; Hardness.

Vijay V. Vazirani — Approximation Algorithms, Springer, 2001
David P. Williamson & David B. Shmoys — The Design of Approximation Algorithms, Cambridge University Press, 2011
Ding-Zhu Du, Ker-I Ko, Xiaodong Hu — Design and Analysis of Approximation Algorithms, Springer, 1997
Dorit S. Hochbaum (Ed.) — Approximation Algorithms for NP-Hard Problems, PWS Publishing, 1997.

IT416N PRIVACY PRESERVING MACHINE LEARNING (3-0-0) 3

Motivation for privacy in ML, Data privacy regulations: GDPR, HIPAA, CCPA. Introduction to Data Privacy, Privacy Breaches, and Threat models in machine learning. Privacy-Preserving Data Analysis and an Introduction to Differential Privacy, Machine Learning Phases and Privacy Threats/Attacks in Each Phase. Types of privacy: Data privacy, model privacy, inference privacy, Introduction to privacy metrics. Anonymisation, pseudonymization, k-anonymity. Concept of differential privacy, Mechanisms: Laplace and Gaussian noise, DP in ML: DP-SGD, Privacy-accuracy trade-off. Federated Learning (FL): Centralized vs. decentralized learning, Federated averaging (FedAvg), Communication and convergence challenges, Split learning. Secure Multi-Party Computation (SMPC), Trusted Execution Environments, Attacks on ML Privacy: Model inversion attacks, Membership inference attacks, Data poisoning & defenses, Case Studies & Applications: Healthcare: Predicting disease without sharing patient data, Finance: Fraud detection, Mobile & IoT applications, Real-world deployment challenges.

Cynthia Dwork & Aaron Roth – The Algorithmic Foundations of Differential Privacy – Now Publishers – 2014
Qiang Yang, Yang Liu, Tianjian Chen & Yongxin Tong – Federated Machine Learning: Concept and Applications – ACM (TIST journal) – 2019
Srinivasa Rao Aravilli – Privacy-Preserving Machine Learning: Principles and Techniques – Packt / O'Reilly – 2024
Ian Goodfellow, Yoshua Bengio & Aaron Courville – Deep Learning – MIT Press – 2016
Nigel Smart – Cryptography Made Simple – Springer – 2016

IT417N TRUSTWORTHY MACHINE LEARNING (3-0-0) 3

Introduction to trustworthy machine learning: Machine learning in the presence of an adversary, Responsible and trustworthy AI. Robustness: Inference in the adversarial setting, Robust inference in the adversarial setting -Various (failed) attempts to build robust models, Adversarial training, Certified robustness using randomized smoothing, Learning in the adversarial setting -Introduction to data poisoning attacks, Influence of training data on models, Methods for designing poisoning data, Backdoor attacks. Quantitative reasoning about data privacy in machine learning. Fairness: Bias in machine learning-Sources and types of bias in machine learning, Formal definitions of fairness, Satisfying fairness criteria in machine learning -Methods for achieving group fairness, Limitations and tradeoffs, Open issues and advanced topics. Federated learning: Robustness and Fairness -Poisoning attacks in federated learning, Robust federated learning, Bias and fairness in federated learning.

Cynthia Dwork and Aaron Roth. "The algorithmic foundations of differential privacy." Foundations and Trends in Theoretical Computer Science 9, 2014.
Solon Barocas, Moritz Hardt, and Arvind Narayanan. "Fairness and machine learning: Limitations and Opportunities." Work in progress book, 2019.
Relevant Research Papers.

IT418N ADVANCED ALGORITHMS (3-0-0) 3

Advanced Divide and Conquer, Greedy, Dynamic Programming, branch and bound algorithms. Combinatorial algorithms, Number theoretic algorithms, Network flow, linear programming, randomised algorithms, parallel algorithms, Online algorithms, Streaming algorithms, String algorithms, Linear programming, Hard Problems, Approximation algorithms, network optimization.

Jon Kleinberg, Éva Tardos – Algorithm Design, Pearson, 2005 (1st ed).
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein – Introduction to Algorithms, MIT Press, 2022
Robert Sedgewick, Kevin Wayne – Algorithms, Addison-Wesley Professional, 2011
Steven S. Skiena – The Algorithm Design Manual, Springer Cham, 2020
Sanjoy Dasgupta – Algorithms, McGraw-Hill,2011
Dimitri P. Bertsekas, John N. Tsitsiklis – Parallel and Distributed Computation: Numerical Methods, Athena Scientific, 2015
C. Xavier, S. S. Iyengar – Introduction to Parallel Algorithms, Wiley, 1998

IT419N ADVANCED DATA STRUCTURES (3-0-0) 3

Mathematical & Computational Foundations, Balanced Search Trees, Multiway & External Memory Trees, Self-Adjusting Trees, Heaps and Priority Queues, Applications in Graph algorithms, Range Query Data Structures, Advanced Graph Data Structures, String Data Structures, Suffix Trees, Geometric Data Structures, Persistent & Functional Data Structures, Randomised & Probabilistic Structures.

Niklaus Wirth – Algorithms + Data Structures = Programs, Prentice-Hall, 1976
Robert E. Tarjan – Data Structures and Network Algorithms, SIAM, 1983
Donald E. Knuth – The Art of Computer Programming, Vols. 1–3, Addison-Wesley, 2015

Chris Okasaki – Purely Functional Data Structures, Cambridge University Press, 1998
Dinesh P. Mehta, Sartaj Sahni (eds.) – Handbook of Data Structures and Applications, 2nd Ed., Chapman & Hall/CRC, 2018
Mark Allen Weiss – Data Structures and Algorithm Analysis (advanced versions),2022
Marcello La Rocca – Advanced Algorithms and Data Structures, Manning, 2021

IT420N POST QUANTUM CRYPTOGRAPHY (3-0-0) 3

Motivation for Post Quantum Cryptography. Quantum threats to hard problems. Basics of error correcting codes, Goppa codes, Introduction to lattices, Useful Lattice Problems, hard problems. Lattice-based cryptography, Regev encryption, ring-SIS, ring LWE, NTRU preliminaries, Kyber, NTRU, Dilithium and FALCON cryptosystems. Code-based cryptography, McEliece public-key cryptosystem, decoding attacks against McEliece, multivariate cryptography, Rainbow cryptosystem, hash-based cryptography, One-time Signature, Isogeny Cryptography.

Daniel J. Bernstein, Johannes Buchmann, Erik Dahmen-Post-quantum cryptography, Springer, 2009
Quantum Computation and Quantum Information by Nielsen and Chuang
NIST Post Quantum Standardization

IT421N SECURE MULTIPARTY COMPUTATION (3-0-0) 3

Basic concepts of Cryptography, Basics of Secure Multi-Party Operations, Secret Sharing, Garbled Circuits, Oblivious Transfers, Perfectly-Secure MPC for Small Number of Parties, Yao's Protocol for Secure 2-party Computation, The BGW Perfectly-Secure MPC Protocol for Linear Functions, The BGW Perfectly-Secure MPC Protocol for Any Arbitrary Function, Homomorphic Encryption, and Zero-Knowledge Proofs, Secure Multiparty Summation, Secure Multiparty Comparison, Secure Function Evaluation, Secure Set Intersection, Secure Matrix Multiplication, Secure Machine Learning Algorithms, Privacy-Preserving Data Analytics, Collaborative Machine Learning and Model Training, Private Information Retrieval.

Carmit Hazay & Yehuda Lindell — Efficient Two-party Protocols: Techniques and Constructions, Springer-Verlag, 2010.
Ashish Choudhury, Arpita Patra-Secure Multi-Party Computation Against Passive Adversaries, Springer, 2024
Thomas Schneider — Engineering Secure Two-party Computation Protocols, Springer-Verlag, 2010.
Ronald Cramer, Ivan Damgård & Jesper Buus Nielsen — Secure Multiparty Computation and Secret Sharing, Cambridge University Press, 2015.

IT422N ADVANCED COMPUTER ARCHITECTURE (3-0-0) 3

Flynn's Classification, RISC Vs CISC, Data and control flow, Pipelining: Linear and non linear, pipeline hazards, instruction scheduling, Branch handling techniques, Arithmetic pipeline, VLIW architecture, Superscalar processors.

Instruction level Data -Parallel architectures: SIMD architectures, Systolic and Vector architecture; MIMD architectures, Systems interconnect architecture: Network properties/routing, Static/dynamic interconnection networks. Multiprocessor architectures, models of memory consistency, cache coherence/directory protocols. Multicore architecture.

J. Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017 Yan Solihin, Fundamentals of Parallel Multicore Architecture, Chapman and Hall/CRC, 2015
Dezso Sima, Peter Karsuk, Advanced Computer Architectures: A Design Space Approach, Addison- Wesley, 2002

IT423N TRANSACTION PROCESSING (3-0-0) 3

Introduction to Transaction Processing - Transaction basics, ACID properties, Transaction systems; Transaction Management - Transaction states, Scheduling concepts, Serializability; Concurrency Control - Locking protocols, Timestamp ordering, Deadlock handling; Recovery Techniques - Failure types, Log recovery, Checkpointing; Distributed Transactions - Distributed databases, Two-phase commit, Distributed control.

Transaction Processing: Concepts and Techniques – Jim Gray and Andreas Reuter, 1992, Morgan Kaufmann.
Concurrency Control and Recovery in Database Systems – Philip A. Bernstein, Vassos Hadzilacos, and Nathan Goodman, 1987, Addison-Wesley.
Database System Concepts – Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, 2019(7th Edition), McGraw-Hill.
Database Management Systems – Raghu Ramakrishnan and Johannes Gehrke, 2003 (3rd Edition), McGraw-Hill.
Principles of Transaction Processing – Philip A. Bernstein and Eric Newcomer, 2009 (2nd Edition), Morgan Kaufmann.

IT424N SOCIAL NETWORK ANALYSIS (3-0-0) 3

Basics of Information networks, Network structures, Models, Processes; Network analysis-concepts, graph centrality measures, Emergence of the Social Web, Statistical Properties of Social Networks; Complete networks, Ego Networks, Random networks, Homophily Small World and Scale-free phenomena, Structural Holes, Sub-groups, Block models, Empirical Models of Network Formation; Complete detection – node – centric, network-centric, group-centric and hierarchy centric approaches, Clique percolation, Spectral clustering, Modularity maximization, Anomaly detection, Louvain Algorithm, Girvan Newman Algorithm; influence maximization, Social network based recommender systems, Large-scale social network analysis applications and case studies, Emerging trends and issues.

J. Goldbeck- Analyzing the Social Web, Morgan Kaufman Publishers, 2015
Yang, Keller and Zherg –Social Network Analysis: Methods and Examples, SAGE Publications, 2016
A. Abraham, A. Hassanien and V. Snasel – Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 2012
Charu C. Aggarwal, - Social Network Data Analytics, Springer; 2014
Select articles from reputed journals like IEEE Transactions on Computational Social Systems, ACM Transaction on Social Computing, Springer Social Network Analysis and Mining, Elsevier Social Networks.

IT425N NEXT GENERATION COMMUNICATIONS (3-0-0) 3

LTE An Overview, Different releases of LTE, 5G Introduction, The E-UTRAN protocol Stack, The core network - EPC, PDN Gateway (P-GW), Service Gateway (S-GW), Mobility Management Entity (MME), Cell Architecture - Small Cell, Femto Cell, Pico Cell, 5G radio protocol architecture - User Planes and Control Planes, Duplexing Schemes, Physical Layer Controlling Signals - Uplink and Downlink, Retransmission Protocol - Hybrid ARQ, Scheduling - Dynamic Uplink and Downlink Scheduling, Handover Techniques, 5G and IoT introduction, Introduction to Machine to Machine (M2M) Communication, Proximity Services (D2D communication), millimeter Wave Communication (mmWave), SDN, 5G Use Cases: Vehicle to Vehicle communication, Aerial Vehicles, Smart City Applications, IoT.

Erik Dahlman, Stefan Parkvall, Johan Sköld, "5G NR: The Next Generation Wireless Access Technology", Elsevier, Academic Press, 2018
Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communication Technology" Cambridge University Press, 2016
Jonathan Rodriguez "Fundamentals of 5G Mobile Networks" , Wiley, 2015

IT426N FINANCE TECHNOLOGY (3-0-0) 3

Role of technology in finance, Digital disruption & legacy systems, FinTech adoption challenges; Payment infrastructure (card networks, gateways), Mobile wallets & UPI, REST APIs in payments, QR payments & contactless tech; blockchain basics for finance, Token economics & DeFi basics; Fraud detection & risk scoring; Algorithmic trading basics; Open banking standards (PSD2), APIs, SDKs, data sharing, FinTech partnerships with banks, Sandbox environments & developer portals; Embedded payments & finance, Banking-as-a-Service (BaaS), White-label financial products; Regulation technology (KYC, AML, GDPR), Risk & compliance frameworks, Cybersecurity principles in finance; BNPL (Buy-Now-Pay-Later), Robo-advisors;

Chishti, S., & Barberis, J. (Eds.). (2016). The FINTECH Book: The financial technology handbook for investors, entrepreneurs and visionaries. John Wiley & Sons.
Benson, C. C., & Loftness, S. J. (2013). Payments systems in the U.S.: A guide for the payments professional (3rd ed.). Glenbrook Partners.
Skinner, C. (2018). Bank 4.0: Banking everywhere, never at a bank. Marshall Cavendish International.
Antonopoulos, A. M. (2017). Mastering Bitcoin: Programming the open blockchain (2nd ed.). O'Reilly Media.
López de Prado, M. (2018). Machine learning for asset managers. Cambridge University Press.

IT427N NOSQL DATABASES (3-0-0) 3

Introduction to NoSQL and Big Data; CAP Theorem and Consistency Models (Eric Brewer); ACID vs BASE Properties; Key–Value Databases (Redis); Document-Oriented Databases (MongoDB); Column-Family Databases (Apache Cassandra); Graph Databases (Neo4j); Data Modelling in NoSQL; Distributed Architecture and Replication; Sharding and Partitioning Techniques; Migration from RDBMS to NoSQL; Cloud-Based NoSQL Services and Applications.

P. J. Sadalage and M. Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. Boston, MA, USA: Addison-Wesley, 2012.
G. Harrison, Next Generation Databases: NoSQL, NewSQL, and Big Data, 2nd ed. New York, NY, USA: Apress, 2015.
K. Chodorow, MongoDB: The Definitive Guide, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2013.
E. Hewitt, Cassandra: The Definitive Guide, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2020.
I. Robinson, J. Webber, and E. Eifrem, Graph Databases, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2021.
E. Redmond and J. R. Wilson, Seven Databases in Seven Weeks, 2nd ed. Dallas, TX, USA: Pragmatic Bookshelf, 2018.

IT428N MEDICAL IMAGE PROCESSING (3-0-0) 3

Introduction to Medical Image Processing: Overview of medical imaging modalities including X ray, CT, MRI, ultrasound and PET. Digital image fundamentals, image acquisition and formation, DICOM, PACS NIfTI, Medical image characteristics and challenges. Image preprocessing techniques including noise reduction, contrast enhancement, filtering and intensity normalization. Image segmentation methods including thresholding, edge based, region based and clustering approaches. Feature extraction and representation for medical images. Image registration and alignment techniques. Medical image classification using traditional machine learning methods. Introduction to deep learning for medical image analysis including CNN based models. Applications in disease detection, organ segmentation and computer aided diagnosis. Evaluation metrics for medical image analysis. Ethical issues, privacy, data security and regulatory considerations in medical imaging systems. Clinical applications and case studies.

Geoff Dougherty, Medical Image Processing: Techniques and Applications, Springer, 2011
Paul Suetens, Fundamentals of Medical Imaging, 3rd Edition, Cambridge University Press, 2017
Zhou, Greenspan and Shen, Deep Learning for Medical Image Analysis, Academic Press, 2017
Wu, Shen and Sabuncu, Machine Learning and Medical Imaging, Academic Press, 2016
Madabhushi and Lee, Medical Image Computing and Computer-Assisted Intervention, Springer, 2019

Review articles from IEEE Transactions on Medical Imaging and Medical Image Analysis Journal

IT429N FUNDAMENTALS OF 5G (3-0-0) 3

LTE An Overview, Different releases of LTE, 5G Introduction, The E- UTRAN protocol Stack, The core network - EPC, PDN Gateway (P-GW), Service Gateway (S-GW), Mobility Management Entity (MME), Cell Architecture - Small Cell, Femto Cell, Pico Cell, 5G radio protocol architecture - User Planes and Control Planes, Duplexing Schemes, Physical Layer Controlling Signals - Uplink and Downlink, Retransmission Protocol - Hybrid ARQ, Scheduling - Dynamic Uplink and Downlink Scheduling, Handover Techniques, 5G and IoT introduction, 5G and IoT Use Cases, Introduction to Machine to Machine (M2M) Communication, Proximity Services (D2D communication), millimeter Wave Communication (mmWave), Massive Multiple Input and Multiple Output (MIMO). 5G Use Cases. Beyond the first release of 5G. 5G Simulation - Implementation of 5G in Network Simulator - 3 (NS-3), patch installation, basic programs on handover and resource allocation.

Erik Dahlman, Stefan Parkvall, Johan Sköld, 5G NR: The Next Generation Wireless Access Technology, Elsevier, Academic Press, 2018
Afif Osseiran, Jose F Monserrat, Patrick Marsch, 5G Mobile and Wireless Communication Technology, Cambridge University Press, 2016
Jonathan Rodriguez Fundamentals of 5G Mobile Networks, Wiley, 2015.

IT430N NARROWBAND INTERNET OF THINGS (3-0-0) 3

Introduction to the Internet of Things. 4G and 5G Systems: LTE History, 5G Narrowband Internet of Things. NB-IoT Applications and Scenarios, Massive Number of Low –Throughput Devices, Longer Battery Lifetime, Low Latency and Data Reporting, LTE NB-IoT Protocol Stack and Architecture, NB-IoT modes of operation, Radio Resource Control Sublayer. Packet Data Convergence Protocol Sublayer. Radio Link Control Sublayer. Medium Access Control Sublayer. Physical Sublayer. Quality of Service Architecture: NB-IoT Quality of Service, Characteristics of QCI, Quality of Service for UE Using CIoT EPS Optimization, QoS Challenges for NB-IoT. Use Cases and Deployment: NB-IoT Devices, Smart Parking, Smart City, Smart Home, Message Queue Telemetry Transport (MQTT), NB-IoT Baseline Deployment, Mobile Operator Deployment. Simulation of Narrowband Internet of Things Networks.

Hossam Fattah, 5G LTE Narrowband Internet of Things (NB-IoT) by, CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkw, 2018

IT431N TIME SERIES ANALYSIS (3-0-0) 3

Introduction, Stochastic Processes, Stationary Time Series Process (Time Domain), Univariate Analysis: Autoregressive (AR) Process. Moving Average (MA) Process, Autoregressive Moving Average (ARMA) Process, Causality, Multivariate Analysis: Autoregressive Distributed Lag (ARDL) Model, Vector Error Correction (VEC) Model, Vector Autoregressive (VAR) Model, Spectral Analysis (Frequency Domain), Non-Stationary Time Series Process, Unit Root Tests: Dickey-Fuller Test Phillips-Peron Test Elliott-Rothenberg-Stock Test, Schmidt-Phillips Test, Kwiatkowski-Phillips-Schmidt -Shin (KPSS) Test, Zivot-Andrews Test, Cointegration introduction and tests, ARCH GARCH Model, Generalized Method of Moments (GMM).

Shumway and D. S. Stoffer (2006), Time Series Analysis and Its Applications (With R Examples), Springer.
kwell, Peter J & Davis, Richard A: Introduction to Time Series and Forecasting. Springer Series, Second Edition. field, Chris: Analysis of Time Series: An Introduction. Chapman & Hall. Sixth Edition.
epohl, Helmut: Introduction to Multiple Time Series Analysis. Springer-Verlag. ilton James D: Time Series Analysis. Princeton University Press.

IT432N SYSTEM INTEGRATION (3-0-0) 3

Enterprise Integration Drivers, Requirements and Strategies, The Business Imperative for Enterprise Integration. Business Drivers and Requirements. Enterprise Integration: Strategy, Architecture Overview.

Current Integration Architecture Assessment. Technical Integration Architecture, Service Integration Architecture, Information Integration Architecture. Process Integration Architecture, Enterprise Integration Solutions: Application, Information, Composite Application and Process-Driven Integrations; Best Practices for Enterprise Integration.

B. G. Bernstein and W. Ruh. Enterprise Integration: The Essential Guide to Integration Solutions, Addison-Wesley.
C. Britton, P. Bye, IT Architecture, Middleware: Strategies for Building Large Integrated Systems, Addison-Wesley.

IT433N RICH INTERNET APPLICATIONS (3-0-0) 3

Web2.0 concepts, SaaS model, Evolution of Web 2.0, Web Programming concepts, HTML, XHTML, CSS, Javascript. JS Execution Environment, Overview of XML, Web Services, Building Rich Internet Applications, AJAX, XML HTTP Object, ActionScript, Products from Industry like Flex (Adobe), Flash/AIR (Adobe)., Silverlight (MS), JavaFX (SUN), OpenLazzlo technologies, Recent Trends.

Robert Sebesta, Programming the World wide web, Pearson Education, Third Edition Nicholas C Zakas et al, Professional AJAX, Wrox publications, 2006
Chafic Kazoun, Programming Flex 2, O'Reilly publications, 2007 Colin Moock, Essential Action script 3.0, O'Reilly Publications, 2007 Steven Holzner, Ajax Bible, Wiley India Edition, 2007
Justin Gehtland et al, A Web 2.0 primer Pragmatic Ajax, SPD Publications, 2006.

IT434N ENTERPRISE RESOURCE PLANNING AND SYSTEMS (3-0-0) 3

ERP: Needs, Models, Commercial ERP Packages, Client Server and Open Technology Solutions, Supply Chain Management-Issues, Drivers and Obstacles, Coordinating SCM and ERP in E-Business

Vinod Kumar G & N.K. Venkitakrishna, ERP- Concepts and Practice, PHI, 1998
Sunil C & Peter-SCM – Strategy and Planning and Operation, Pearson Education, LPE, 2002 Pete Loshin, Paul A. Murphy, Electronic Commerce, A JAICO Book.

IT435N SIMULATION AND MODELLING (3-0-0) 3

System models and Role of Simulation, Types of Systems, Statistical Tools and Techniques, Discrete Event Simulation Languages, Modelling and Performance Evaluation of Computer Systems, Biological and Sociological System Simulation, Verification and Validation.

A. M. Law and W.D. Kelton, Simulation Modelling and Analysis, McGraw Hill, 2000
A. M. Law, Simulation Modelling and Analysis, McGraw Hill, 4th Edition, 2008

IT436N E-COMMERCE (3-0-0) 3

Infrastructure and Tools for E-Commerce, Current Trends in E-Commerce applications development, The Business of Internet Commerce, Enterprise level E-Commerce, Security and encryption, Electronic payment systems, Search engines, Intelligent agents in E-Commerce, On-line auctions, Data mining for e-commerce, Web metrics, Recommender systems, Knowledge management, Mobile e-commerce, Legal, ethical and social issues.

Henry Chan et al., E-Commerce- Fundamental and applications, John Wiley & Sons, 2002
G. Winfield Treese and Lawrence C.S, Designing Systems for Internet Commerce, Pearson Education, LPE, 2002 Fensel, Dieter, Brodie M. L., Ontologies: A Silver Bullet for Knowledge Management and E-Commerce, Allied Publishers, 2004.
Zimmermann, Olaf; Tomlinson, Mark R.; Peuser, Stefan, Perspectives on Web Services, Allied Publishers, 2004.

IT437N PRIVACY PRESERVING DATA PUBLISHING (3-0-0) 3

Data Collection and Data Publishing, Anonymisation, Information Metrics, Attack Models and Privacy models: Record linkage model, attribute linkage model, Table linkage model, probabilistic model, modelling adversary's background knowledge, Anonymization operations and algorithms, Anonymization for data mining Anonymizing transaction data, Anonymizing Social Networks, One-time data publishing, Multiple time data publishing, Graph data and other data types.

Benjamin C.M. Fung, Ke Wang, Ada Wai-Chee Fu, and Philip S. Yu, Introduction to Privacy-Preserving Data Publishing: Concepts and Techniques, Chapman & Hall/CRC,2010.
Raymond Chi-Wing Wong, · Ada Wai-Chee Fu, Privacy-Preserving Data Publishing: An Overview, Springer, 2022.

IT438N CLOUD AND DATA INTENSIVE APPLICATIONS (3-0-0) 3

Introduction to Cloud Computing, Cloud Computing Delivery Models. Technologies for Network based systems- SOA – Hardware- MultiCore Systems – GPGPU- Data Storage. Cloud issues and challenges - Properties - Characteristics - Service models: Infrastructure as a Service (IaaS) - Platform as a Service (PaaS) - Software as a Service (SaaS) - Anything as a service (XaaS) – Service Management, Deployment models- Virtualization – Virtual Machines – Hypervisor Types – Resource Virtualization Technology. Cloud Programming and Software Environments: Hadoop Framework–Programming on Amazon AWS and Microsoft Azure – Programming support of Google App Engine. Cloud Security, Cloud Application Design & Development, Containers and Dockers. Reliable, Scalable, and Maintainable Systems, Batch & Stream Processing: MapReduce, Distributed Filesystems, Batch/Stream Processing, Message Brokers (Kafka, RabbitMQ).

Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, Distributed and cloud computing from Parallel Processing to the Internet of Things, Morgan Kaufmann, Elsevier, First Edition, 2013.
Rajkumar Buyya, James Broberg, Andrzej Goscinski, & Cloud Computing Principles and Paradigms Wiley, First Edition, 2011.
Martin Kleppmann, Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, And Maintainable Systems, O'Reilly Media, 2017
Barrie Sosinsky, Cloud Computing Bible, John Wiley & Sons, First Edition, 2010
Tim Mather, Subra Kumaraswamy, and Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly, First Edition, 2009
s*James Turnbull, The Docker Book: Containerization Is the New Virtualization, e-book, First Edition, 2015.*

IT398N/ IT448N/ IT498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

IT399N MAJOR PROJECT - I (0-0-18) 9

IT449N MAJOR PROJECT - II (0-0-18) 9

IT499N MAJOR PROJECT - III (0-0-18) 9

Department of Information Technology (IT)
Bachelor of Technology in Artificial Intelligence

Basic Science Core Courses (BSC)

PH100N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
MA108N	Applied Linear Algebra and Graph Theory	(3-0-0)3
MA105N	Probability and Statistics	(3-0-0)3
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

CS101N	Computer Programming	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
UC101N	Introduction to Engineering	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core (PC)

AI200N	Data Structures	(3-0-0)3
AI201N	Foundations of Machine Learning	(3-0-0)3
AI202N	Mathematical Foundation of AI	(3-0-0)3
AI203N	Database Systems	(3-0-0)3
AI204N	Data Structures Lab	(0-0-2)1
AI205N	Foundations of Machine Learning Lab	(0-0-2)1
AI206N	Database Systems Lab	(0-0-2)1
AI207N	Python Programming	(0-0-4)2
AI208N	Object Oriented Programming	(0-0-2)1
AI250N	Design and Analysis of Algorithms	(3-0-0)3
AI251N	Deep Learning	(3-0-0)3
AI252N	Foundations of Computing Systems	(2-0-2)3
AI253N	Design and Analysis of Algorithms Lab	(0-0-2)1
AI254N	Deep Learning Lab	(0-0-2)1
AI255N	Data Analytics	(1-0-4)3
AI256N	High Performance Computing Lab	(0-0-2)1
AI300N	Natural Language Processing	(3-0-0)3
AI301N	Reinforcement Learning	(3-0-0)3
AI302N	Machine Learning Security	(2-0-2)3
AI303N	Natural Language Processing Lab	(0-0-2)1
AI304N	Reinforcement Learning Lab	(0-0-2)1
AI305N	Machine Learning Operations	(0-0-4)2
AI306N	Agentic AI	(1-0-2)2

Programme Specific Elective Courses (PSE)

AI275N	Operating Systems	(3-0-0)3
AI276N	Computer Networks	(3-0-0)3
AI277N	Cognitive Networks	(3-0-0)3
AI278N	Computer Organization and Architecture	(3-0-0)3
AI279N	Data Visualisation	(3-0-0)3
AI280N	Number Theory and Cryptography	(3-0-0)3
AI281N	Game Theory	(3-0-0)3
AI282N	Knowledge Representation and Reasoning	(3-0-0)3
AI283N	Autonomous Agents	(3-0-0)3
AI284N	Stochastic Processes	(3-0-0)3
AI350N	Cloud Computing	(3-0-0)3
AI351N	Theory of Computation	(3-0-0)3
AI352N	Brain Computer Interfaces	(3-0-0)3
AI353N	Human Centered Computing	(3-0-0)3
AI354N	Genetic Algorithms	(3-0-0)3
AI355N	Computational Biology	(3-0-0)3
AI356N	Intelligent Data Management	(3-0-0)3
AI357N	Information Retrieval	(3-0-0)3
AI358N	Performance Modelling	(3-0-0)3
AI359N	Social Computing	(3-0-0)3
AI360N	Data Warehousing and Data Mining	(3-0-0)3
AI361N	User Experience Design	(3-0-0)3
AI362N	Computer Vision	(3-0-0)3
AI363N	Robotics	(3-0-0)3
AI364N	Soft Computing	(3-0-0)3
AI365N	Cyber Security	(3-0-0)3
AI400N	Distributed Computing Systems	(3-0-0)3
AI401N	Quantum Computing	(3-0-0)3
AI402N	Quantum Machine Learning	(3-0-0)3
AI403N	Computational Auditory Perception	(3-0-0)3
AI404N	Computational Visual Perception	(3-0-0)3
AI405N	Computational Photography	(3-0-0)3
AI406N	Sentiment Analysis	(3-0-0)3
AI407N	Advanced Database Systems	(3-0-0)3
AI408N	Pattern Recognition	(3-0-0)3
AI409N	AI in Healthcare	(3-0-0)3
AI410N	Speech Processing	(3-0-0)3
AI411N	GPU Computing	(3-0-0)3
AI412N	Edge AI	(3-0-0)3
AI413N	Smart Systems Development	(3-0-0)3
AI414N	Industry 5.0	(3-0-0)3
AI415N	Quantum Cryptography	(3-0-0)3
AI416N	Digital Forensics	(3-0-0)3
AI417N	Autonomous Cyber Physical Systems	(3-0-0)3
AI418N	Generative AI	(3-0-0)3
AI419N	Responsible AI	(3-0-0)3
AI420N	Applied Algorithms	(3-0-0)3
AI421N	Randomized Algorithms	(3-0-0)3
AI422N	Approximation Algorithms	(3-0-0)3
AI423N	Privacy Preserving Machine Learning	(3-0-0)3
AI424N	Trustworthy Machine Learning	(3-0-0)3
AI425N	Advanced Algorithms	(3-0-0)3
AI426N	Advanced Data Structures	(3-0-0)3
AI427N	Post Quantum Cryptography	(3-0-0)3
AI428N	Secure Multiparty Computation	(3-0-0)3

AI429N	Privacy Preserving Data Publishing	(3-0-0)3
AI430N	Path Planning	(3-0-0)3
AI431N	Hardware Platforms for AI	(3-0-0)3
AI432N	Time Series Analysis	(3-0-0)3
AI433N	Big Data Analytics	(3-0-0)3
AI434N	Internet of Things	(3-0-0)3
AI435N	Blockchain Technology	(3-0-0)3
AI436N	Causal Inference	(3-0-0)3

Internship

AI398N	Internship I	(0-0-18)9
AI448N	Internship II	(0-0-18)9
AI498N	Internship III	(0-0-18)9

Major Project

AI399N	Major Project I	(0-0-18)9
AI449N	Major Project II	(0-0-18)9
AI499N	Major Project III	(0-0-18)9

Suggested Plan of Study for B.Tech. in Artificial Intelligence:

Semester	I	II	III	IV	V	VI	VII	VIII
1	CY100N	PH100N	AI200N	AI250N	AI300N	AI398N/ AI399N	AI448N/ AI449N	AI498N/ AI499N
2	MA108N	MA105N	AI201N	AI251N	AI301N	Elective 1	Elective 4	Elective 6
3	UC100N	CS101N	AI202N	AI252N	AI302N	Elective 2	Elective 5	Elective 7
4	DE100N	UC101N	AI203N	AI253N	AI303N	Elective 3	Honor / Minor	Honor / Minor
5	UC103N	UC102N	AI204N	AI254N	AI304N	Honor / Minor		
6	PL1XWN / PL1X9N	PL1YWN / PL1Y9N	AI205N	AI255N	AI305N			
7			AI206N	AI256N	AI306N			
8			AI207N	Dept. Elective *	PL3XWN / PL3X9N			
9			AI208N	PL2YWN / PL2Y9N	Honor / Minor			
10			PL2XWN / PL2X9N	Honor / Minor				

Requirements for B.Tech. in Artificial Intelligence:

Category of Courses	Minimum Credits to be Earned
Basic Science Core (BSC)	20
General Engineering Courses (GEC)	12
Programme Core Courses (PCC)	48
Elective Courses (EC)	24 (21+3*)
Internship / Major Project	27
Life Skill	20
Total	151

* *Department Elective*

AI200N DATA STRUCTURES (3-0-0) 3

Elementary Data Types and Abstract Data Types. Computational model and complexity of algorithms (running time and space metrics), Introduction to Asymptotic notation; Worst-case, Best-case, Average-case and amortised analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT and its implementation using arrays and linked lists. Types of linked lists: Single, Double, circular linked lists and their applications. Stack ADT and Queue ADT implementations with applications. Dynamic set ADT and Dictionary ADT. Hash tables – collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, B-trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Merge sort and Quick sort. Randomized Quick sort and its analysis. Linear-time sorting algorithms like Radix and Counting sort. Graphs: Definitions and representations. Depth-first and breadth-first search and their applications. Basic Graph algorithms like Dijkstra's shortest path algorithm and Kruskal's MST algorithm.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.
Alfred V Aho, John E Hopcroft, Jeffrey D Ullman, "Data Structures and Algorithms", Addison Wesley, 2003.
T H Cormen, C E Leiserson, R L Rivest, and C Stein, Introduction to Algorithms, 3rd Edition, PHI Learning, 2010.
S. Horowitz. Fundamentals of Data Structures in C, Universities Press, 2nd Edition, 2008.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Pearson, 2011

AI201N FOUNDATIONS OF MACHINE LEARNING (3-0-0) 3

Introduction to Machine Learning (ML): Definition and learning paradigms, including supervised, unsupervised and reinforcement learning. ML workflow covering data, features, models, loss functions, training and evaluation. Bias-variance tradeoff, overfitting and underfitting, data splits and generalisation. Supervised learning methods such as linear regression and logistic regression, basic loss functions and evaluation metrics including accuracy, precision, recall, F1 score and ROC AUC. Instance-based and margin-based learning using kNN and SVM. Decision trees with interpretability and overfitting issues. Ensemble methods, including bagging, Random Forests and boosting. Probabilistic learning covering generative and discriminative models and Naive Bayes. Model selection using cross-validation, hyperparameter tuning and error analysis. Unsupervised learning, k-means, hierarchical and density-based clustering and applications. Representation learning using PCA and embeddings.

Tom M. Mitchell, Machine Learning, McGraw Hill Education, Indian Edition - 2017 (International Edition - 1997).
Kevin P. Murphy, Probabilistic Machine Learning, An introduction., MIT Press, 2022.
Bernhard Scholkopf and Alexander J. Smola, Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond., MIT Press, Cambridge, MA, USA, 2001.
Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.
Aurélien Géron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition
Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, A Bradford Book; 2018.
Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012.

AI202N MATHEMATICAL FOUNDATION OF AI (3-0-0) 3

Mathematical and Propositional Logic, Proof Techniques, Sets, Relations, Functions, Partially Ordered Sets, Lattices, Boolean Algebra, Groups, Rings and Fields. Induction, Strong Induction, Well-Ordering Principle, Recursive Definitions and Structural Induction; Generating Functions, and Recurrence Relations; Optimization Methods: Constrained & Unconstrained, Continuous & Discrete, Convex & Non-Convex; Gradient, Newton and Quasi-Newton Methods, Line Search, Linear Programming Problem Formulation. Lagrange Multipliers,

Karush–Kuhn–Tucker (KKT) Conditions, Penalty & Barrier Methods, Problems with Equality Constraints. Metaheuristic Optimization Techniques.

Kenneth H Rosen, Discrete Mathematics and Its Applications. 8th ed., McGraw-Hill Education, 2019.
Ralph P Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th edition,2019.
Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2004.
Jorge Nocedal and Stephen J. Wright, Numerical Optimization, 2nd Edition, Springer, 2006.
Edwin K. P. Chong and Stanislaw H. Żak, An Introduction to Optimization, John Wiley, 4th Edn, 2013.
M N Murty and Ananthanarayana V S, Machine Learning: Theory and Practice, Universities Press, Hyderabad, 2024

AI203N DATABASE SYSTEMS (3-0-0) 3

Basic Concepts, Data models: ER, EER; Logical Database Design: Normalization; Physical Database Design: Storage organization, Indexing; Query Languages – Procedural, Non-procedural, SQL; Query Processing, Transaction processing: Concurrency Control and Recovery; Trends in database systems.

Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2014
R. Elmasri and S.B Navathe, Fundamentals of Database Systems,7th Ed., Pearson, 2017
Silberschatz, Korth A.F., Sudarshan S., Database System Concepts, 6th Ed., McGraw-Hill,2010.

AI204N DATASTRUCTURES LAB (0-0-2) 1

Implementation of List ADT operations using arrays and linked lists. Applications of Lists. Stacks, Queues, and Circular Queues implementation and application. Implementing Hash Tables with chaining and open addressing. AVL tree implementation, B-tree implementation, Application of trees. Array and pointer-based implementation of Binary heaps. Applications of Priority Queues. Searching and sorting. Applications to real-world problems.

AI205N FOUNDATIONS OF MACHINE LEARNING LAB (0-0-2) 1

Introduction to ML Lab: Python based ML environment using NumPy, Pandas and Scikit learn. Dataset loading, missing value handling and train validation test splits. Exploratory data analysis including visualization, normalization, standardization, categorical encoding and data leakage detection. Regression algorithms, Overfitting and pruning. Ensemble methods, Probabilistic learning. Model selection experiments with cross validation hyperparameter tuning, Unsupervised learning, Dimensionality reduction techniques.

AI206N DATABASE SYSTEMS LAB (0-0-2) 1

Design of Database Systems for applications such as office automation, hotel management, and hospital management. Normalization and Query Processing (in terms of disk accesses) in the above-mentioned application projects. Implementation of a few key functionalities of relational database management systems.

AI207N PYTHON PROGRAMMING (0-0-4) 2

Programming Languages, Python Basics, Variables and Data Types, Control Structures, Repetition structures, Functions and Modules, Strings, Lists, File Input and Output, Basic Data Structures, Object-Oriented Programming, NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with Pandas - Reading, Manipulating, and Processing Data, Python web frameworks

Martin C. Brown, Python: The Complete Reference, McGraw Hill Education; Fourth edition, 2018
Mark Summerfield, Programming in Python 3: A Complete Intro to the Python Language, Pearson, 2018

AI208N OBJECT ORIENTED PROGRAMMING (0-0-2) 1

Basics of OOP: classes and objects, abstraction, encapsulation, inheritance, polymorphism, and message passing, object creation, memory management, and basic exception handling using an object-oriented language such as Java or C++. Exercises on dynamic binding, exception handling, templates/generics, file handling, and standard libraries (STL in C++ and Collections Framework in Java), enabling comparison between the two languages.

Schildt, H. (2022). Java: The complete reference (12th ed.). McGraw Hill Education.
Stroustrup, B. (2013). The C++ programming language (4th ed.). Addison-Wesley.

AI250N DESIGN AND ANALYSIS OF ALGORITHMS (3-0-0) 3

Models of computation, Proof techniques for correctness, Proving correctness of recursive and non-recursive algorithms, algorithm analysis, asymptotic notation, time and space complexity, average-/best-/worst-case analysis. Recurrence Tree and Master Method. Amortised analysis. Divide and Conquer (Integer Multiplication, Inversions, Closest Pair of Points, Merge Sort etc.), Greedy Algorithms (Scheduling, Huffman Coding, MST & Shortest Path Algorithms etc.), Dynamic Programming (Knapsack, Matrix Multiplication, Optimal Binary Search Tree, Weighted Independent Set, Interval Scheduling) with proof of correctness, Backtracking & Branch-and-Bound and Apps. Randomised Algorithms (Game Tree Evaluation, Quicksort, Order statistics, Min-Cut Problem). Reductions and P, NP, NP-Complete Classes (3-SAT, Vertex Cover, Subset-Sum, Partition. Introduction to Approximation Algorithms.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S. Dasgupta, C. Papadimitriou, and U. Vazirani, Algorithms, McGraw-Hill Education, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3rd Edition, PHI, 2010.
Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2nd Edition, 2013.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2nd Edition, 2009
Michael R. Garey, David S. Johnson, Computers and Intractability: A Guide to the Theory of NP-completeness, W.H. Freeman & Co Ltd, 1979.

AI251N DEEP LEARNING (3-0-0) 3

Introduction to Deep Learning: Motivation and its relationship with ML and representation learning. Neural network basics including perceptron model, activation functions and loss functions. Training neural networks using gradient descent and backpropagation. Deep feedforward networks, initialization techniques and regularization methods. Optimization methods including SGD, momentum, RMSProp and Adam. Convolutional Neural Networks: convolution operation, pooling, architectures and applications in image classification. Sequence Modelling and Recurrent Neural Networks including vanishing gradient problem, LSTM and GRU architectures and applications to time series and text. Attention mechanisms and transformer architecture overview. Autoencoders and representation learning. Introduction to generative models including variational autoencoders and GANs. Model evaluation, hyperparameter tuning and practical considerations in deep learning systems. Ethical considerations, bias in deep learning models and responsible AI.

Josh Patterson and Adam Gibson, "Deep learning: A Practitioner's Approach", O'Reilly, 2017
Ian Goodfellow, Y. Bengio and A. Courville, "Deep Learning", MIT Press, 2016.
Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015
Li Deng and Dong Yu, "Deep Learning: Methods and Applications", 2013
Koller, D. and Friedman, N. Probabilistic Graphical Models . MIT Press. 2009

AI252N FOUNDATIONS OF COMPUTING SYSTEMS (2-0-2) 3

Computer system overview, Performance metrics, Von Neumann vs Harvard architecture, Instruction Set Architecture (ISA): RISC vs CISC, Instruction formats and addressing modes, organization: registers, ALU, control unit. Introduction to pipelining(conceptual), I/O organization: programmed I/O, interrupts. Role and structure of operating systems, System calls and OS services, Process concept and process states, Threads and multithreading basics, CPU scheduling, Scheduling criteria and performance evaluation, Memory hierarchy, Cache memory, Virtual memory concepts, Memory management techniques, Paging, segmentation. Introduction to Computer Network: Network topologies, OSI and TCP/IP reference models, Functions of each layer. IP addressing and subnetting, IPv4 and IPv6 overview, Transport layer: TCP vs UDP, Flow control and congestion control, Introduction to Common network applications like HTTP, FTP, DNS etc

Carl Hamacher et al., Computer Organization and Embedded Systems, Sixth Edition, McGraw-Hill, 2014.
Vincent P Heuring, Harry F Jordan, T. G. Venkatesh, Computer Systems Design and Architecture, Pearson, 2008.
Miles Murdocca and Vincent Heuring, Computer Architecture & Organization An Integrated Approach, Wiley, 2007.
J. Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017.
Andrew S. Tannenbaum and Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2015 Abraham Silberschatz et al., Operating System Concepts, 9th Ed., John Wiley, 2012
"Data Communications and Networking", Behrouz A. Forouzan, 4th Edition, McGraw Hill, 2017. "Data and Computer Communications", William Stallings, 10th Edition, Pearson, 2013.

AI253N DESIGN AND ANALYSIS OF ALGORITHMS LAB (0-0-2) 1

Algorithm Design and Implementation of the Lab Exercises are related to the following topics: Divide and Conquer (Integer Multiplication, Inversions, Closest Pair of Points, Merge & Quicksort etc.), Greedy Algorithms (Scheduling, Huffman Coding (Compression), MST/Shortest Path Algorithms etc.), Dynamic Programming (Knapsack, Matrix Multiplication, Optimal Binary Search Tree, Weighted Independent Set etc.), Backtracking and Branch-and-Bound Techniques and the Real-Life Applications. Randomized Algorithms. Reductions and Class P, NP, NP-Complete Classes, Approximation algorithms.

AI254N DEEP LEARNING LAB (0-0-2) 1

Design and implementation of deep learning models using Python based frameworks. Design of 1D, 2D and 3D CNNs. Development of deep feedforward neural networks with backpropagation and testing using appropriate datasets. Image classification using deep neural networks on benchmark datasets such as MNIST and CIFAR 10. Implementation and comparison of activation functions. Encoder decoder architectures and simple attention mechanisms with applications to images. Design and implementation of autoencoders & its relation to PCA incl. regularized, denoising, sparse and contractive autoencoders. Implementation of regularization techniques including bias variance tradeoff, L2 regularization, data augmentation and parameter sharing. Motion analysis and object tracking using deep learning techniques. Implementation of word embedding techniques for natural language processing. Design and implementation of recurrent neural networks including backpropagation through time and analysis of vanishing and exploding gradients, sequence models using GRU and LSTM networks with attention mechanisms, Transformer model architecture.

AI255N DATA ANALYTICS (1-0-4) 3

Introduction to Data Analytics: structured, semi-structured and unstructured data. Statistical and Inferential analytics, Hypothesis testing; Data preprocessing techniques including data cleaning, transformation and normalization, Techniques for Missing and noisy data handling, correcting inconsistent data; Correlation and Covariance analysis; Dimensionality reduction techniques, Feature Engineering: Filter/wrapper methods; Similarity based analysis including distance measures, similarity metrics and nearest neighbor search; Mining

data streams, Intro to Big Data Analytics, Mining social network graphs; Storytelling with data and principles of effective data visualization; Use of data visualization and business intelligence tools such as Power BI and Tableau. Real-World Case studies.

Aurélien Géron, Hands On ML with Scikit Learn, Keras and TensorFlow, 3rd Ed, O'Reilly Media, 2022.
Frank Kane, Hands On Data Science and Python Machine Learning, Packt Publishing, 2019.
Alvaro Fuentes, Hands On Predictive Analytics with Python, Packt Publishing, 2018.
Jake VanderPlas, Python Data Science Handbook, 2nd Edition, O'Reilly Media, 2023.
Stefanie Molin, Hands On Data Analysis with Pandas, 2nd Edition, O'Reilly Media, 2022
Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015
Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: Springer, 2009.
Jure Leskovec et al., "Mining of Massive Datasets" Cambridge University Press, 2014

AI256N HIGH PERFORMANCE COMPUTING LAB (0-0-2) 1

Introduction to Parallel Computer Architectures, Introduction to Memory, Network, Parallel Programming, Parallel Programming with OpenMP, MPI. Introduction to accelerator and heterogeneous programming using CUDA/OpenCL.

J. Dongara, I. Foster, G. Fox, W. Cropp et al, & quot; Sourcebook of Parallel Programming & quot; Morgan Kaufmann, 2002.
Barbara Chapman et.al, "OpenMP: Portable Shared Memory Parallel Programming", Scientific & Engineering
Computation, MIT 2008.
B. Wilkinson and M. Allen, & quot; Parallel Programming: Techniques and Applications", 2nd ed., Pearson, 2004.
Benedict R. Gaster et al., Heterogeneous Computing with OpenCL, 2nd Edition, Morgan Kaufmann. 2012.
Rezaur Rahman, Intel Xeon-Phi Coprocessor Architecture/Tools - The Guide for App. Developers, Apress, 2013.
CUDA for Engineers by Duane Storti and Mete Yurgotlu, Addison-Wesley, 2016
P. S. Pacheco, An Introduction to Parallel Programming, Elsevier, 2011
Sergei Kurgalin and Sergei Borzunov, A practical approach to High Performance Computing, Springer, 2019

AI300N NATURAL LANGUAGE PROCESSING (3-0-0) 3

Introduction to linguistics and levels of language analysis. Building blocks of language and challenges in NLP. Approaches to NLP. Text preprocessing including tokenization, normalization and stemming. N gram models. Syntactic and semantic analysis including POS tagging, information extraction, named entity recognition, relation extraction and parsing techniques. Probabilistic models such as HMM and Maximum Entropy. Semantic analysis covering word sense disambiguation, semantic similarity, WordNet and topic Modelling. Distributional semantics and neural language models. Word and sentence embeddings including Word2Vec, GloVe, FastText and contextualized embeddings using BERT and its variants. NLP applications include text classification, sentiment analysis, text summarization, machine translation, chatbots, dialog systems, question answering and fake news detection. NLP pipelines and deployment. Large Language Models. NLP applications in healthcare, education and multimodal systems. Research challenges and emerging applications.

Daniel Jurafsky and James H. Martin. "Speech and Language Processing: An Introduction to NLP", PH 2000.
Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical NLP" MIT Press, 1999
James Allen, "Natural Language Understanding". Benjamin/Cummings, 2ed, 1995
Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, Released June 2020, Publisher(s): O'Reilly Media, Inc.

AI301N REINFORCEMENT LEARNING (3-0-0) 3

Introduction to Reinforcement Learning, Markov Processes Markov Reward Processes (MRPs) Markov Decision Processes (MDPs), MDP Policies, Policy Evaluation, Policy Improvement, Policy Iteration, Value operators, Model free learning - Q-learning, SARSA, Scaling up: RL with function approximation, RL with function approximation, Imitation learning in large spaces, Policy search, Exploration/Exploitation, Meta-Learning, Batch Reinforcement Learning, Bandit problems and online learning, Solution methods: dynamic programming, Monte Carlo learning, Temporal difference learning, Eligibility traces, Value function approximation, Models and planning, Case studies: successful examples of RL systems, Frontiers of RL research

Richard S. Sutton and Andrew G. Barto: Reinforcement Learning: An Introduction, MIT Press, 2015
Deep Learning, by Ian Goodfellow, Yoshua Bengio, and Aaron Courville., MIT press, 2016
Reinforcement Learning: State-of-the-Art by Marco Wiering and Martijn van Otterlo, Eds. 2012
Artificial Intelligence: A Modern Approach by Stuart J. Russell and Peter Norvig, 4th edition, 2010

AI302N MACHINE LEARNING SECURITY (2-0-2) 3

Introduction to Distributed Machine Learning, Security Challenges, Secure Training Techniques. Federated Learning and Security Issues. Cryptography and security fundamentals, differential privacy. Secure Computation, Secure Multiparty Computation. A Framework for Securing AI and Machine Learning Models: Security Goals, Threat Model and Mitigating Risk. Adversarial machine learning, attacks on machine learning models. Privacy-preserving machine learning models. Using ML for cybersecurity: Malware analysis, Intrusion Detection, Anomaly Detection. - Generative AI Security- Risks in LMMs- Prompt injection and future research directions

Yevgeniy Vorobeychik and Murat Kantarcioglu, Adversarial Machine Learning, Morgan & Claypool (2018)
David Evans, Vladimir Kolesnikov, Mike Rosulek, A Pragmatic Introduction to Secure Multi-Party Computation, NOW Publishers, 2018
Ashish Choudhury, Arpita Patra, Secure Multi-Party Computation Against Passive Adversaries, Springer International Publishing AG; 1st ed. 2022 edition
C. Dwork and A. Roth. The Algorithmic Foundations of Differential Privacy, now publishers Inc, 2014

AI303N NATURAL LANGUAGE PROCESSING LAB (0-0-2) 1

Text processing techniques including tokenization and normalization. Named entity recognition and relation extraction. Context free parsing and dependency parsing. Word sense disambiguation, WordNet and topic Modelling. Word embeddings using Word2Vec, GloVe and FastText. Sentence embeddings and recursive embeddings. Contextualized embeddings using BERT. Applications including sentiment analysis, aspect level sentiment analysis, text summarization, recommender systems, question answering and chatbots. Large Language Models including supervised fine tuning, prompting techniques and multimodal applications.

Daniel Jurafsky and James H. Martin. "Speech and Language Processing: An Introduction to NLP", PH 2000.
Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical NLP" MIT Press, 1999
James Allen, "Natural Language Understanding". Benjamin/Cummings, 2ed, 1995
Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, Released June 2020, Publisher(s): O'Reilly Media, Inc.

AI304N REINFORCEMENT LEARNING LAB (0-0-2) 1

Markov Decision Processes applications, Value-based methods such as value iteration and policy iteration. Model-free learning using Monte Carlo methods and Q-learning, Exploration and exploitation strategies, Reward design and shaping for guiding agent behavior. Function approximation using neural networks for

large state spaces. Deep Q-Networks with experience, replay and target networks. Custom reinforcement learning environments and training pipelines for applied decision-making problems.

AI305N MACHINE LEARNING OPERATIONS (0-0-4) 2

Machine Learning Pipelines: data collection, preprocessing, feature engineering, and model training; pipeline orchestration using tools such as Kubeflow, MLflow, and Airflow; versioning datasets, models, and experiments to ensure reproducibility. Model Deployment: serving ML models as REST APIs, handling batch and real-time inference, containerization using Docker, and orchestration with Kubernetes. Continuous Integration and Continuous Delivery (CI/CD) for ML: automating data validation, model testing, and deployment; Git-based workflows for ML projects using GitLab CI/CD, Jenkins, and CircleCI. Monitoring, Logging, and Model Management: monitoring model performance and drift, logging model inputs, predictions, and errors, implementing retraining strategies, and rollback mechanisms. Cloud-Based MLOps: deployment of ML models on AWS SageMaker, Google AI Platform, and Azure ML; using managed ML services and understanding scalability considerations.

Huyen, C. (2022). Designing ML Systems: An iterative process for production-ready applications. O'Reilly Media.
Gift, N., & Deza, A. (2021). Practical MLOps: Operationalizing machine learning models. O'Reilly Media.
Lakshmanan, V., Robinson, S., & Munn, M. (2020). Machine learning engineering in action. Manning Publications.
Hapke, H., & Nelson, C. (2020). Building ML pipelines: Automating model life cycles with TensorFlow. O'Reilly Media.
Treveil, M., Omont, N., Stenac, C., Lefevre, K., Phan, D., Zentici, J., Lavoillotte, A., & Heidmann, L. (2020). Introducing MLOps: How to scale machine learning in the enterprise. O'Reilly Media.

AI306N AGENTIC AI (1-0-2) 2

Introduction to agentic systems and lab environment setup using Python based frameworks such as LangChain, LangGraph and LlamaIndex. Implementation of simple rule based and reflex agents. Design of goal driven and utility based agents. State representation and environment Modelling with simulation of deterministic and stochastic environments. Planning and action selection including task decomposition and simple planners. Large language model based agents using prompt based reasoning, tool use and function calling. Construction of single agent workflows and planning with language models. Introduction to multi agent systems including communication, coordination and cooperative and competitive behaviors. Evaluation of agentic systems focusing on robustness, failure modes, hallucination and safety testing. Mini project involving design and implementation of an end to end agentic AI system for real world tasks.

Ken Huang (Ed.), Agentic AI: Theories and Practices, Springer Nature, 2025
Nicole Koenigstein, AI Agents: The Definitive Guide, O'Reilly Media, 2025
Anjanava Biswas & Wrick Talukdar, Building Agentic AI Systems: Create intelligent, autonomous AI agents that can reason, plan, and adapt, Packt Publishing, 2025

AI275N OPERATING SYSTEMS (3-0-0) 3

Operating Systems Overview, Interrupt Sources and Priorities, Interrupt Service Routines; User and Kernel Threads, Synchronization, Critical Section Problem; Process Synchronization and Coordination, Semaphores, Monitors; Inter Process Communication; Deadlock Prevention, Avoidance, Detection, Recovery; CPU Scheduling Algorithms, Memory Management, File System Organization; Mobile Operating Systems: ARM & Intel Architectures, Mobile OS Architectures, Runtime Issues, Approaches to Power Management; Introduction to device drivers.

Andrew S. Tannenbaum and Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2015
Abraham Silberschatz et al., Operating System Concepts, 9th Ed., John Wiley, 2012.

Harvey M. Deitel et al., Operating System, 3rd Edition, Pearson, 2007.
William Stallings, Operating Systems: Internals and Design Principles. 9th Ed., Pearson, 2017.
M. J. Bach. Design of the Unix Operating System, 1st Edition, Pearson, 2015.
Jonathan Corbet et al., Linux Device Drivers, 4th Edition, O'Reilly, 2013.

AI276N COMPUTER NETWORKS (3-0-0) 3

Introduction to computer networks and Internet; Understanding of Delay, Loss and Throughput in the packet switching network, protocols layers and their service model, The Link layer and Local area networks: Introduction and link layer services, error-detection and correction techniques, Multiple access protocols, addressing, Ethernet, switches. Network Layer: Introduction, Virtual and Datagram networks, study of router, IP protocol & addressing in the Internet, Routing algorithms, Broadcast & Multicast routing. Transport Layer: Introduction and transport layer services, Multiplexing & Demultiplexing, Connection less transport (UDP), Reliable data transfer, Connection oriented transport (TCP), Congestion control. Application Layer: Principles of computer applications, Web & HTTP, E-mail, DNS, Socket programming with TCP & UDP.

Kurose and Ross, "Computer Networking- A Top-Down Approach", 6th Edition, Pearson 2012
Andrew S Tanenbaum, "Computer Networks", 4th Edition, Prentice Hall, 2002
Behrouz A Forouzan, "Data Communications and Networking", 4th Edition, McGraw Hill, 2007

AI277N COGNITIVE NETWORKS (3-0-0) 3

Cooperative and Cognitive Networks Introduction, Adaptive Networks, Dynamic Factors, Network Functions, Representative Adaptive Techniques, , Self Managing Networks, Concepts and Challenges, Theories for designing Self-Management Networks, Self-Management Intelligence, Machine Learning for Cognitive Networks-Technology Assessment and Research Challenges, Evolution of Adaptive Systems, Biologically Inspired Networking, Principles, Evolutionary and Adaptive Systems, Swarm Intelligence, Cross-Layer Design and Optimization in Wireless Networks, Cognitive Radio Architecture, Cognitive Ad hoc Networks, Distributed Learning and Reasoning in Cognitive Networks – Methods and Design Decisions, applying Evolutionary Approaches for Cooperation in Networks, Intelligence in Router and Switches,

" Cognitive Networks Towards Self Aware Networks" Qusay H Mahmoud, Wiley Publications, 2007
"Cognitive Wireless Networks: Concepts, Methodologies and Vision Inspiring the Age of Enlightenment of Wireless Communications", Frank H.P. Fitzek and Marcos D. Katz, Springer, 2007
"CISCO Router and switch Forensics Investigating and Analyzing Malicious Network Activity" Dale Liu, Singress Publications, 2009.

AI278N COMPUTER ORGANIZATION AND ARCHITECTURE (3-0-0) 3

Introduction to computer organization and architecture, Instruction Sets, Data path design, Fixed point and floating point arithmetic operations and hardware design, ALU design, Micro-Operation, Microarchitecture and Instruction Set Architecture, Control unit and Design, Hardwired control unit and Micro programmed control unit, Horizontal micro-programmed and Vertical micro-programmed control unit, Memory organization, Cache memory, Multilevel Cache Organization, Virtual memory, Input output Unit: Priority Interrupts, Programmed Controlled I/O Transfer, Interrupt controlled I/O transfer, DMA controller, Secondary storage and type of storage devices, Introduction to solid-state drive (SSD), Read and Write operations in memory, Pipelining. Performance evaluation.

Carl Hamacher et al., Computer Organization and Embedded Systems, Sixth Edition, McGraw-Hill, 2014.
Vincent P Heuring, Harry F Jordan, T. G. Venkatesh, Computer Systems Design and Architecture, Pearson, 2008.
Murdocca and Heuring, Computer Architecture & Organization: An Integrated Approach, Wiley, 2007.
Hennesy and Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017.

AI279N DATA VISUALISATION (3-0-0) 3

Overview of visualization, graphics, drawing, photorealism, human perception - Visualization of Numerical Data- Data, mapping, charts, glyphs, parallel coordinates, stacked graphs, Tufte's design rules, using color - Visualization of Non- Numerical Data - Graphs, networks, treemaps, Principle Component Analysis, multidimensional scaling, packing - Visualization systems, Information Visualization, database visualization, visualization system design - Trends in Data Visualization and Other Tools - Declarative programming, reactive programming.

Visualization Analysis and Design, Tamara Munzner, AK Peters Visualization Series, CRC Press, Nov. 2014
Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics Nathan Yau, Wiley (2011)
Donahue, Rafe. "Fundamental statistical concepts in presenting data: principles for constructing better graphics." (2011).

AI280N NUMBER THEORY AND CRYPTOGRAPHY (3-0-0) 3

Number Theory: Divisibility theory in the integers, Primes and their Distribution, The theory of congruences, Fermat's theorem, Number-theoretic functions, Euler's generalisation of Fermat's theorem, Primitive roots and indices, The quadratic reciprocity law. Review of abstract, Algebra – Groups, rings and fields. Primality Testing – Fermat test, Carmichael numbers, Solvay-Strassen Test, Miller-Rabin Test, etc. Classical Cryptosystems, Symmetric Key Cryptography, Public Key Cryptography, Various adversarial attacks and proof of security, Cryptographic Hash functions, Digital Signatures, Provable security, Key Exchange and Authentication, Identification Schemes, Commitment Scheme, Secret Sharing, Verifiable Electronic Elections, Elliptic Curve Cryptography, Various applications and protocols.

J. Katz and Y. Lindell, Introduction to Modern Cryptography, Third edition CRC press, 2020
Menezes Bernard, Network Security and Cryptography, 1st Edition, Cengage Learning India, 2010.
Neal Koblitz, "Number theory and cryptography", Springer, 2007.
Hans Delfs, Helmut Knebl, "Introduction to Cryptography: Principles and Applications", Springer
Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, "Handbook of Applied Cryptography", CRC Press, 1996.
Stinson. D. Cryptography: Theory and Practice, 3rd edition, Chapman & Hall/CRC, 2012.

AI281N GAME THEORY (3-0-0) 3

Introduction to Game Theory, Quantifying the Inefficiency of Equilibrium: Nash Equilibrium, Routing Games and Congestion Games, Network Formation and Games in Networks, Price of Anarchy and Price of Stability, The Smoothness Framework, Coalitional Stability, Auctions and Mechanism Design: Algorithmic Mechanism Design and Auctions, Second-price and First-price Auctions, Combinatorial Auctions, Truthful Mechanisms, Approximately Efficient Mechanisms, Bayesian Mechanism Design, Maximizing Revenue in Auctions, Ad Auctions, Sponsored- Search Auctions, Quality of Stable Solutions in Simple Auction Mechanisms; Markets and Pricing: Social Welfare and Walrasian Equilibrium, Gross-Substitutes, Single-Minded Valuations, Maximizing Revenue via Pricing, Sequential Buyer Arrival, Combinatorial Walrasian Equilibrium; Algorithmic Aspects of Equilibrium: Existence and Complexity of Finding Equilibrium, Correlated and Coarse-Correlated Equilibrium, No-regret Learning

Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, Algorithmic Game Theory, Cambridge University Press ,2007.
Ronald Cohn Jesse Russell, Algorithmic Game Theory, VSD Publishers, 2012.

AI282N KNOWLEDGE REPRESENTATION AND REASONING (3-0-0) 3

Role of knowledge in intelligent systems, Issues in knowledge representation, Knowledge vs data vs information; Logic as a Knowledge Representation Language, Logical equivalence, Inference rules; First Order

Predicate Logic (FOPL), Functions and relations, Translating natural language to FOPL, Resolution principle; Rule-Based Systems & Production Rules; Semantic networks, Inheritance and hierarchies, Frames and slots, Default values, Object-centered knowledge; Ontology concepts, Taxonomies, Classes and properties, Description logic basics, OWL and RDF overview; Limitations of classical logic, Probability theory basics, Bayesian reasoning, Bayesian networks, Certainty factors; Closed world assumption, Default logic, Truth maintenance systems (TMS), Belief revision, Reasoning with exceptions; Case-based reasoning (CBR), Similarity measures, Fuzzy sets and fuzzy logic, Fuzzy inference systems; Knowledge graphs, Entities, relationships, and triples (Subject–Predicate–Object);

Barrasa, J., & Webber, J. Building Knowledge Graphs: A Practitioner's Guide. O'Reilly, 2023.
Kejriwal, M., Knoblock, C. A., & Szekely, P. Knowledge Graphs: Fundamentals, Techniques, and Apps. MIT Press, 2021.
Brachman, R. J., & Levesque, H. J. Knowledge representation and reasoning. Morgan Kaufmann Publishers, 2004.

AI283N AUTONOMOUS AGENTS (3-0-0) 3

Agents Overview: Agent definition, agent programming paradigms, Agents Vs objects, mobile agents, Agent frame works, Agent reasoning; Agents Implementation: Processes, threads, Sockets, RPCs – distributed computing, aglets programming – JINI architecture, actors and agents. Multi Agent Systems: Interaction between agents, reactive agents, cognitive agents, interaction protocols, agent coordination, agent negotiation, agent cooperation, agent organization, self –interested agents in electronic commerce applications. Intelligent Software Agents: Interface Agents, Agent Communication Languages, Agent Knowledge Representation, Agent Adaptability, Belief Desire Intension, Mobile Agent, Applications. Agents and Security: Agent Security Issues, Mobile Agents Security, Protecting Agents Malicious Hosts, Untrusted Agents, Black box Security, Authentication for Agents, Security issues for Aglets.

Joseph P. Bigus and Jennifer Bigus, "Constructing Intelligent Agents Using Java: Professional Developer's Guide", Wiley, Second edition, 2001.
Bradshaw, "Software Agents", MIT Press, 2000
Michael Wooldridge, An Introduction to MultiAgent Systems - Second Edition. Wiley, 2009
Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, Introduction to Autonomous Mobile Robots - Second Edition. MIT Press, 2011
Rafael H. Bordini, Jomi Fred Hubner and Michael Wooldridge, Programming Multi-agent Systems in AgentSpeak Using Jason. Wiley, 2007

AI284N STOCHASTIC PROCESSES (3-0-0) 3

Discrete-time Markov chains: Definition and examples of discrete-time Markov chains, Chapman-Kolmogorov equations, Long run behaviour of Markov chains, Absorption probabilities and expected times to absorption, Statistical aspects of Markov chains, The mover-stayer model, Application of a Markov chain and mover-stayer model to modelling. Continuous-time Markov chains: Definition of a continuous-time Markov chain and examples, Poisson process, The Kolmogorov differential equations, Limiting behaviour of continuous-time Markov chains, birth and death processes, Statistical aspects and applications of continuous-time Markov chains. Discrete-time martingales: Conditional expectation, Definition of a martingale and examples, Optional stopping theorem, Applications to random walks, Martingales in option pricing- a simple example; Brownian Motion and its generalizations: Motivation, definition and properties of Brownian motion, Geometric Brownian motion, Continuous-time martingales, Optional stopping theorem; Stochastic calculus: Stochastic integration, Ito's formula, Black-Scholes option pricing formula

Introduction to Probability and Stochastic Processes with Applications, Castaneda, Arunachalam, Dharmaraja, Wiley, 2012
G.F. Lawler, Introduction to Stochastic Processes (Second Edition), Chapman and Hall, Probability Series, 2006.

H.M. Taylor and S. Karlin, An Introduction to Stochastic Modelling, Academic Press, Third Edition, 1994

AI350N CLOUD COMPUTING (3-0-0) 3

Concept of cloud computing and evolution. Define SLAs and SLOs and illustrate their importance in Cloud Computing, Threats in cloud security, Common cloud providers and their associated cloud stacks and popular cloud use case scenarios. Cloud infrastructure: Cloud Reference Architecture. Cloud software deployment considerations such as scaling strategies, Load balancing, Fault tolerance, and Optimizing for cost. Cloud resource management: Virtualizing CPUs, full virtualization, Para-virtualization, and Memory virtualization. Cloud storage: Organization of data and storage. HDFS, Google GFS, Big-Table. Programming models: Fundamental aspects of parallel and distributed programming models. Cloud programming models (Map reduce, Spark, Graph Lab and Spark Streaming). Map-reduce programming model.

Anthony T Velte, Cloud Computing: A Practical Approach, McGraw Hill,2010
J. Lin and C. Dyer, Data Intensive Text Processing with MapReduce, , Morgan and Claypool, 2010
T. Velte, A. Velte, R. Elsenpeter, Cloud Computing, A Practical Approach, McGraw Hill, 2009
Rajkumar Buyya, James Broberg, Andrzej M., Cloud Computing: Principles and Paradigms, Wiley, 2010.
Dan Marinescu, Cloud Computing: Theory and Practice, Morgan Kaufmann, 2013

AI351N THEORY OF COMPUTATION (3-0-0) 3

Formal Languages and Automata Theory: Generative grammar, Chomsky hierarchy, Finite state Automata: Definition, Concept of Non-determinism, Equivalence of deterministic and Non-deterministic Automata, regular languages; Closure properties. Pushdown Automata: Definition, Equivalence between NPDA and context free grammars, Pumping Lemma for C.F.L's, Decision problems, Closure properties. Turing machines: Definition, extension to Turing machines: Multi-track, Multi-tape, and Non determinism. TM as an acceptor, TM as a computing device; P, NP, NP-Hard & NP- Complete problems

J.E. Hopcroft and J.D. Ullman, Introduction to automata, Languages and computation, Addison Wesley.1969
M. Sipser, Theory of Computation, Cengage, 2013.
H.E. Lewis and C.H. Papadimitiou, Elements of the Theory of Computation, Prentice-Hall of India, 1981.
Derickwood, Theory of Computation, John Wiley & Sons, 1987.

AI352N BRAIN COMPUTER INTERFACES (3-0-0) 3

Signal Recording & Stimulation: Recording Signals, Simultaneous Recording & Stimulation; Signal Processing: Frequency Domain Analysis, Fourier Analysis, Discrete Fourier Transforms, Fast Fourier Transforms, Spectral Features, Wavelet Analysis, Time Domain Analysis - Convolution and Correlation, Principal Component Analysis and Independent Component Analysis; Brain Computer Interfaces (BCI): Types, Invasive, Semi-Invasive, Non-Invasive, Stimulating, Bidirectional and Recurrent BCIs, Applications, Medical and Non-Medical, Ethics of BCI.

Rajesh P N Rao, "Brain Computer Interfacing: An Introduction", Cambridge University Press, 2013
Jonathan R Wolpaw, Elizabeth Winter Wolpaw (Eds.), "Brain Computer Interfaces: Principles and Practice", Oxford University Press, 1st edition, 2012.
Desney S Tan, Anton Nijholt (Eds.), "Brain Computer Interfaces: Applying Our Minds to HCI", Springer 2010.

AI353N HUMAN CENTERED COMPUTING (3-0-0) 3

Overview of Human Physiology, Psychology and Usability Factors; Immersive Reality Technologies, Virtual Reality, Augmented Reality and Mixed Reality Systems Design, Prototyping, Framework for Evaluating the Current and Emerging Immersive Reality Technologies and Applications; Design and Technological Foundations for Immersive Experiences; Input Devices – Controllers, Motion Trackers and Motion Capture Technologies for Tracking, Navigation: Touch, Gesture and Marking, Speech, Language and Audition Control; Output Devices – Head Mounted VR Displays, Augmented and Mixed Reality Glasses; 3D Interfaces:

Interactive & Procedural Graphics; Immersive Surround Sound; Haptic and Vibrotactile Devices; Systems Architecture and Integrative Immersive Media Platforms; Rapid Prototyping and Physical Computing, VR programming.

Kelly S. Hale, Kay M. Stanney (Eds.), "Handbook of Virtual Environments: Design, Implementation, and Applications", CRC Press, Second Edition, 2015.
Jason Jerald, "The VR Book: Human-Centered Design for Virtual Reality", Association for Computing Machinery and Morgan & Claypool Publishers, 2015.
Bowman, Doug A.; Kruijff, Ernst; LaViola Jr., Joseph J.; Poupyrev, Ivan, "3D User Interfaces: Theory and Practice", Addison-Wesley, 1st Edition, 2005.

AI354N GENETIC ALGORITHMS (3-0-0) 3

Introduction, Possible Applications, Pros and Cons, Principles of Evolutionary Processes and Genetics Introduction to Evolutionary Computation: Biological and artificial evolution, evolutionary computation and AI, different historical branches of EC, a simple genetic algorithm. Search Operators: Crossover, mutation, crossover and mutation rates, Crossover for real-valued representations, mutation for real-valued representations, combinatorial GA, Selection Schemes: Fitness proportional selection and fitness scaling, ranking, tournament selection, selection pressure and its impact on evolutionary search. Theoretical Analysis of Evolutionary Algorithms: Schema theorems, convergence of the algorithms, computational time complexity of the algorithms, no free lunch theorem. Search Operators and Representations: Mixing different search operators, adaptive representations. Niching and Speciation: Fitness sharing, crowding and mating restriction. Constraint Handling: Common techniques, penalty methods, repair methods, Deb's penalty parameter method. Multi-objective evolutionary optimization: Pareto optimality, multi-objective evolutionary algorithms: MOGA, NSGA-II. Engineering Applications of GA, job-shop scheduling and routing problems. Evolutionary robotics and evolutionary hardware: Evolving control. Evolving morphology. Body-brain co- evolution. Evolution in simulation and in reality. The case for and against simulation.

Goldberg D.E. Genetic Algorithms in Search, Optimization and Machine Learning. Pearson Education Asia, 2002
K. Deb, Multi-Objective Optimization Using Evolutionary Algorithms, Wiley and Sons, 2009.
M. Mitchell, An introduction to genetic algorithms, MIT Press, 1996.
L. D. Davis, Evolutionary algorithms, Springer-Verlag, 1999.
Evolutionary Computation: A Unified Approach by Kenneth A. DeJong, MIT Press, 2006, ISBN: 0262041944
Bäck, T, 2000. Evolutionary Computation 1: Basic Algorithms and Operators. Institute of Physics Publishing, Bristol. Jacob, C., 2001. Illustrating Evolutionary Computation with Mathematica. Morgan Kaufmann.

AI355N COMPUTATIONAL BIOLOGY (3-0-0) 3

Introduction to Bioinformatics, Biological Databanks, Biological Sequence Analysis: Genome-Microarray, pairwise sequence alignment, Dynamic programming, global and local alignment, Progressive multiple sequence alignment, Iterative multiple sequence alignment. BLAST Scoring matrices, gap penalty, statistical significance of multiple sequence alignment, sum-of-pairs method, CLUSTAL W, searching motifs in sequence alignment. Phylogenetics – distance-based using UPGMA, Neighbour Joining. Protein Structure prediction – Secondary Structure prediction, Protein Secondary Structural Class prediction, Protein Fold recognition, Protein Tertiary Structure prediction. Protein- Protein Interaction, Protein Subcellular Localization, Emerging Areas in Bioinformatics.

Durbin, R., Eddy, S., Krough, A. & Mitchison, G., Biological sequence analysis: probabilistic models of proteins and nucleic acids. Cambridge University Press, 1998.
Jones, N.C. & Pevzner, P.A., An introduction to bioinformatics algorithms. MIT Press, 2004.
David Mount, Bioinformatics: Sequence and Genome Analysis by Cold Spring Harbor Laboratory Press, 2001
R. Durbin, S. Eddy, A. Krogh and G. Mitchison, Biological Sequence Analysis: Probabilistic models of proteins and nucleic acids Cambridge University Press,1998

Xiaohua Hu and Yi Pan, Knowledge Discovery in Bioinformatics: Techniques, Methods, and Applications, John Wiley, 2007
A Metaheuristic Approach to Protein Structure Prediction by Jana, Nanda Dulal, Das, Swagatam, Sil, Jaya, Springer, 2018
H.M. Taylor and S. Karlin, An Introduction to Stochastic Modelling, Academic Press, Third Edition, 1994

AI356N INTELLIGENT DATA MANAGEMENT (3-0-0) 3

Data Modelling - Designing Logical Data Models - Physical Data Models - Leveraging Data Models-Data relationships- Conceptual Graph - Representing Conceptual Structures - Reasoning with Graphs - Semantic Graph - Relationships between Categorical Variables - Tabular Representation of Associations - Graphical Representation of Associations - Interpretation & Results Comparison -Datastorage perspectives; Transaction Processing- Basics of Fault Tolerance- Transaction-Oriented Computing - Concurrency and Recovery

John F. Sowa, "Conceptual Graphs Summary," in Conceptual Structures: Current Research and Practice, P. Eklund, T. Nagle, J. Nagle, and L. Gerholz (Eds.), Ellis Horwood, pp. 3-52, 1992.
Jim Gray and Andreas Reuter. 1992. Transaction Processing: Concepts and Techniques (1st ed.). Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.
R. Elmasri and S.B Navathe, "Fundamentals of Database Systems", 2000.

AI357N INFORMATION RETRIEVAL (3-0-0) 3

Introduction: Basic Concepts, Information need vs. Query, Modern Search Interface requirements, IR System Architecture, Preprocessing techniques, Tokenizing, Indexing, Classic IR Models for unstructured data, Inverted Index, Vector Space Model, Best Match models, Probabilistic models Implementation of IR models, Structured IR models, Multimedia IR, Experimental Evaluation of IR Systems, Implicit and Explicit Relevance Feedback techniques, Document/Query Properties and Representations, Web Search and Link analysis algorithms, Recommender Systems, Learning to Rank and Learning the ranking function based techniques, RAG, Selected research papers on emerging trends and open problems in IR.

C. D. Manning, P. Raghavan and H. Schütze, "Introduction to Information Retrieval",, Cambridge University Press. 2008.
Baeza-Yates & Ribeiro-Neto, "Modern Information Retrieval", Pearson Education, 2010
Donald Metzler, Trevor Strohman, and W. Bruce Croft, "Search Engines: Information Retrieval in Practice", Pearson Education, 2010

AI358N PERFORMANCE MODELLING (3-0-0) 3

Operational Laws: Little's Law, response-time law, asymptotic bounds, modification analysis, performance metrics; Markov Chain Theory: discrete-time Markov chains, continuous-time Markov chains, renewal theory, time- reversibility; Poisson Process: memorylessness, Bernoulli splitting, uniformity, PASTA; Queueing Theory: open networks, closed networks, time-reversibility, Renewal Reward, M/M/1, M/M/k, M/M/k/k, Burke's theorem, Jackson networks, classed networks, load-dependent servers, BCMP result and proof, M/G/1 full analysis, M/G/k, G/G/1, transform analysis (Laplace and z-transforms); Simulations: time averages versus ensemble averages, generating random variables for simulation, Inspection Paradox; Modelling Empirical Workloads: heavy-tailed property, Pareto distributions, heavy-tailed distributions, understanding variability and tail behavior, Matrix analytic methods; Management of Server Farms: capacity provisioning, dynamic power management, routing policies; Analysis of Scheduling: FCFS, non-preemptive priorities, preemptive priorities, PS, LCFS, FB, SJF, PSJF, SRPT, etc

Mor Harchol-Balter, Performance Modelling and Design of Computer Systems: Queueing Theory in Action, Cambridge University Press.
Papoulis and S. U. Pillai, Probability, Random Variables, and Stochastic Processes, McGraw-Hill. Leon-Garcia, Probability and Random Processes for Electrical Engineering, Prentice Hall.

Michael Pinedo, Scheduling Theory, Algorithms, and Systems, Prentice Hall.

AI359N SOCIAL COMPUTING (3-0-0) 3

Emergence of the Social Web, Statistical Properties of Social Networks, Network analysis -concepts and graph centrality measures, Complete networks, Ego Networks, Random networks, Homophily, Small World Phenomenon, Structural Holes, Time, Sub-groups, Blockmodels and Strategic Network Formation, Empirical Models of Network Formation, Community detection, Influence maximization, Link mining and prediction, Social network based recommender systems, Anomaly detection in social networks, Mining Discussion networks, Visualizing Online Social Networks, Large-scale social network analysis applications and case studies, Emerging trends and issues.

Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 2012
Charu C. Aggarwal, —Social Network Data Analytics, Springer; 2014
Evolution in Social Networks. Ajith Abraham, Aboul Ella Hassanien, Václav Snášel
Borko Furht, —Handbook of Social Network Technologies and Applications, Springer, 1st edition, 2011 Giles, Mark Smith, John Yen, —Advances in Social Network Mining and Analysis, Springer, 2010.

AI360N DATA WAREHOUSING AND DATA MINING (3-0-0) 3

Intro to data mining: Motivation and significance of data mining, Data mining on what kind of data?, data mining functionalities, interestingness measures, classification of data mining system, major issues in data mining; Data pre-processing: Need, data summarization, data cleaning, data integration and transformation, Attribute subset selection methods: filter based and wrapper based methods, Information gain based, correlation based, Minimum redundancy maximum relevance based methods, data discretization and concept hierarchy generalization. Data warehouse and OLAP technology: multidimensional data model(s), data warehouse architecture, OLAP server types, data warehouse implementation, on-line analytical processing and mining; Data cube computation and data generalization. Mining frequent patterns, associations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms: A-priori and FP Tree methods, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining; Colossal item set Mining: Enumeration methods, Dynamic switching method, parallel method, sequential pattern mining; Bayesian classification, associative classification, lazy learners, grid based and density based clustering methods, Clustering high dimensional data; Data mining on complex data and applications: Algorithms for mining multimedia data, text data, multimodal data, biological sequence data; Data mining applications and trends in data mining.

Han, J. and Kamber, M., "Data Mining - Concepts and Techniques", 3rd Ed., Morgan Kaufmann Series, (Elsevier), 2008.
Alex Berson, S. J. Smith, "Data Warehousing, Data Mining & OLAP", McGraw Hill
Tan, P.N., Steinbach, M. and Kumar, V., "Introduction to Data Mining", Addison Wesley Pearson, 2006 Pujari, A. K., "Data Mining Techniques", 4th Ed., Sangam Books.
Oded Maimon, Lior Rokach, The Data Mining and Knowledge Discovery Handbook, Springer, 2005.
S. Weiss and N. Indurkhya, Predictive Data-Mining: A Practical Guide, Morgan Kaufmann, 1998
S. Weiss, N. Indurkhya, T. Zhang and F. Damerau, Text Mining: Predictive Methods for Analyzing Unstructured Information, Springer, 2004.

AI361N USER EXPERIENCE DESIGN (3-0-0) 3

UI/UX Overview: Intro to UI/UX,Finding bad UI/UX design; Design: Introduction,Design Toolkit and UI/UX Notebook;User Research:How to identify stakeholders, Defining stakeholders, How to identify user needs,Creating UX Flows,User Journeys:Mapping the user journey, Finding solutions & constraint cards, User Experience Design techniques such as scenarios, personas, storyboards, wireframing, and information architecture; UX Principles: Present Sketches, UX Principles, Converting Sketches to Grayscales, Psychology of UX; User Testing:Understanding user testing, Prepare grayscales for user testing, think aloud testing; UI

Principles:layout and alignment, Finding good UI, color and text,Visual Design Specification;UI Components: buttons, icons, controls, prototyping.

Interaction Design: Beyond Human-Computer Interaction, by Rogers, Sharp, and Preece, ISBN-10 # 0470665769 The Design of Everyday Things, by Norman, ISBN-10 # 0465050654
Buxton B. Sketching user experiences: getting the design right and the right design. Morgan Kaufmann; 2010.
Zwick C, Schmitz B. Designing for Small Screens: Mobile Phones, Smart Phones, PDAs, Pocket PCs, Navigation Systems, MP3 Players, Game Consoles, Bloomsbury Publishing; 2005.

AI362N COMPUTER VISION (3-0-0) 3

Introduction to Computer Vision, Color + Math basics, Pixels and filters, Edge detection, Features and fitting, Feature descriptors, Resizing, Semantic segmentation, Clustering, Object recognition, Face identification, Visual Bag of Words, Detecting objects by parts, Image classification, Motion Tracking.

Sonka M., Hlavac V., Boyle R., Image Processing Analysis and Machine Design. PWS Publishers Ballard D., Brown C., Computer Vision, Prentice Hall, 1982.
R. C. Gonzalez and R. E. Woods, Digital Image Processing, Addison Wesley, 1992.

AI363N ROBOTICS (3-0-0) 3

Introduction to Robotics, RTOS, Robotic programming, Robot Kinematics & Motion, Perception in Robotics, Localization & Mapping, Motion Planning & Path Planning, Machine Learning in Robotics, Control Systems & Autonomous Decision Making, Human-Robot Interaction & Ethics, Advanced Topics.

Craig JJ. Introduction to Robotics: mechanics and control, 3/E. Pearson Education India; 2009.
Bongard J. Probabilistic Robotics. Sebastian Thrun, Wolfram Burgard, Dieter Fox, MIT press; 2005.
Sutton RS, Barto AG. Reinforcement Learning: An introduction. Cambridge: MIT press; 1998.

AI364N SOFT COMPUTING (3-0-0) 3

Fuzzy logic: Classical sets and Fuzzy sets, Fuzzy sets operations, Fuzzy relations, Membership functions, Defuzzification, Fuzzy rule based systems. Fuzzy implications. Solving optimization problems, Concept of Genetic algorithm -Fitness function, Genetic operators: selection, crossover, mutation. Swarm optimization techniques: Particle swarm optimization and Global swarm optimization, Nature inspired techniques. Hybrid of soft computing and machine learning methods: GA-Kmeans, GA based wrapper feature selection method, Fuzzy clustering, Fuzzy classifier, Integration of genetic algorithms with neural networks, Integration of genetic algorithms with fuzzy logic; Multi objective evolutionary algorithm approaches, Applications and Recent Research Trends

Ross T.J., Fuzzy logic with engineering applications-McGraw Hill, 1995
J. M. Zurada, Introduction to artificial neural networks, Jaico publishing, 1997.
Goldberg D., Genetic algorithms- Addison-Wesley, 1st edition,1989.
S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing 2nd edition, Wiley, 2011.
Shishir K. Shandilya, Smita Shandilya, Kusum Deep, Atulya K. Nagar, Handbook of Research on Soft Computing and Nature-Inspired Algorithms, IGI Global, 2017.
Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer), 2007
J. Han and M. Kambar, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers (Elsevier), 2008.

AI365N CYBER SECURITY (3-0-0) 3

Introduction, Types of Attacks, Digital Privacy, Online Tracking, Privacy Laws, Types of Computer Security risks, Antivirus Social Engineering, Secure online browsing, Secure WIFI settings, Cryptography and Secure

Communication: Cryptographic Functions, Digital Signature, The Difference Between Digital Signatures and Electronic Signatures, Cryptographic Systems Trust Models, Create a Cryptographic Key Pair Using Gpg4win/gpg4usb, Disk Encryption Using Windows BitLocker, Disk Encryption Using Open Source Tools, Multitask Encryption Tools, Cloud storage security, IoT security, Physical Security Threads. Online Anonymity: Anonymous Networks, Tor Network, I2P Network, Freenet, Darknet, VPN, Proxy Server, Secure network protocols (SSL/TLS, SSH, IPsec), Encrypt DNS Traffic and Email communication, Secure IM and video calls. Anonymous OS, System security - Patch management and system hardening Cyber Crime Issues and Investigation: White collar Crimes, Viruses and Malicious Code, Internet Hacking and Cracking, Virus Attacks, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Digital laws and legislation, Law Enforcement Roles and Responses, Investigation Tools, eDiscovery, EDRM Model.

Nihad Hassan, Rami Hijazi, "Digital Privacy and Security Using Windows: A Practical Guide" Apress. "Network Security Essentials", William Stallings, 4th Edition, Pearson Education, 2008.
"Internet and Intranet Security", Rolf Oppliger, 2nd Edition, Artech House, 2007.
"Applied Cryptography, Code Complete, Secure Programming", Articles and papers from http://securityresearch.in. "Fundamental Problems in Provable Security and Cryptography", Alexander W. Dent (Research Paper). "Cryptography: An Introduction", Nigel Smart, 3rd Edition, Mcgraw-Hill, 2013.
"Cryptography and Network Security", Behrouz A Forouzan/ Mukhopadhyay, 3rd Ed., McGraw-Hill, 2015.

AI400N DISTRIBUTED COMPUTING SYSTEMS (3-0-0) 3

Basic concepts - Computer networks, Distributed systems and Computing, Design goals, Fundamental issues and transparencies in DCS, Ordering of events, Ordering of messages and concerned protocols, Global state detection Process synchronization, Process communications, Load balancing techniques.

Mukesh Singhal and Niranjan G. Shivaratri, Advanced Concepts in Operating System, Tata McGraw Hill, 1994.
A.S Tanenbaum and M.V. Steen, Distributed Systems – Principles and Paradigms, Prentice-Hall, 2006.
Randy Chow, Distributed Operating Systems and Algorithms, Addison Wesley, 1997.
G.F. Coulouies, J.D. Dollimore and T. Kindberg, Distributed Systems: Concepts & Design, Addison Wesley, 1994.

AI401N QUANTUM COMPUTING (3-0-0) 3

History of quantum computation and quantum information, Future directions, Basic Mathematics: Linear operators and matrices, Tensor products, Operator functions. Quantum Logics: QISKIT, Introduction to Qubit, Single qubit operation, Multiple Qubit operation, Single qubit gates, Multiple qubit Gates, Controlled Not gate, Swap gate, Toffoli gate, Universal quantum gates. Quantum Algorithms and Applications: The quantum search algorithm, Quantum search as a quantum simulation, Quantum counting, Speeding up the solution of NP complete problem, Quantum search of an unstructured database, Optimality of the search algorithm.

Michael. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum information, Cambridge University Press 2000.
Bellac Michel Le, "A short introduction to quantum information and quantum computation", Cambridge University Press, 2006
Vishal Sahni, "Quantum Computing", Tata McGrawHill, 2007.
Richard L. Liboff, Introductory Quantum Mechanics, Pearson, Fourth Edition (2003).

AI402N QUANTUM MACHINE LEARNING (3-0-0) 3

Introduction to Complex Numbers, Basics of Linear Algebra, and Computational Complexity, Quantum Computing Paradigms: Gate-Based Quantum Computing, Measurement-based Quantum Computing, Quantum Algorithm. Fundamentals of Machine Learning for Quantum Systems, Quantum Data Encodings: Superposition for basis encodings, Amplitude amplification, Feature Maps, Quantum random access memory,

Quantum Support Vector Machines, Variational Quantum Circuits (VQCs), Variational eigen-solvers, Variational quantum algorithm, quantum variational eigen-solver (VQE), quantum variational circuits (VQC, Quantum Kernel Methods, Quantum Neural Networks, Hybrid Quantum-Classical Architectures, Quantum Approximate Optimization Algorithm, Applications and Future Trends in Quantum Computing

Michael A. Nielsen and Isaac L. Chuang. Quantum Computation and Quantum Information: 10th Anniversary Edition. Cambridge University Press, 2010.
M. Schuld and F. Petruccione. Machine Learning with Quantum Computers. Quantum Science and Technology. Springer International Publishing, 2021.
Jarrod R McClean, Jonathan Romero, Ryan Babbush, and Al´an Aspuru-Guzik. The theory of variational hybrid quantum-classical algorithms. New Journal of Physics, 18(2):023023, feb 2016.
Schuld, M., & Petruccione, F., Supervised Learning with Quantum Computers, Springer.

AI403N COMPUTATIONAL AUDITORY PERCEPTION (3-0-0) 3

Cognitive Neuroscience: Mind and Brain, Structure and Function of the Brain Nervous System, Methods of Cognitive Neuroscience, Hemispheric Specialization, Sensation and Perception, Object Recognition, Attention, Action, Learning and Memory, Emotion, Thinking and Problem Solving, Language, Cognitive Control, Social Cognition, Consciousness.

Michael S. Gazzaniga, Richard B. Ivry, George R. Mangun, "Cognitive Neuroscience: The Biology of the Mind", W. W. Norton & Company; Fifth Edition, December 1, 2018.
Bernard J Baars, Nicole M Gage, "Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience", Academic Press and Elsevier Ltd., 2nd Edition, 2010.
Michael S. Gazzaniga (Ed.), "The Cognitive Neurosciences", The MIT Press, 4th Edition, 2009.

AI404N COMPUTATIONAL VISUAL PERCEPTION (3-0-0) 3

Fundamentals of Image and Video Processing; Image and Video Analysis: Image Transforms - DCT, Hadamard, Haar, KL and Wavelets; Image and Video Compression Standards: JPEG, JPEG2000, MPEG1, MPEG2, MPEG4 & MPEG7; Image and Video Rendering and Assessment; Human Visual Perception; Perceptual Video Quality Metrics, Perceptual Coding and Processing of Digital Pictures; Image and Video Storage, Retrieval; Applications and Research Trends.

Perceptual Based Image Processing, Morgan & Claypool, 2009
Al Bovik, “Handbook of Image and Video Processing”, Elsevier Academic Press, 2005
H. R. Wu and K. R. Rao, “Digital Video Image Quality and Perceptual Coding”, CRC Press, 2005
R. C. Gonzalez and R E Woods, “Digital Image Processing”, Pearson Education, 2002
William K Pratt, “Digital Image Processing”, Wiley, 2001.

AI405N COMPUTATIONAL PHOTOGRAPHY (3-0-0) 3

Camera geometry and optics, Focus and depth, Computational apertures and shutters, Exposure and high dynamic range, Flash / no flash photography, Super-resolution and denoising. Photo quality assessment, Image filtering and image pyramids, Image blending and compositing Texture synthesis and inputting, non photorealistic rendering Single / multi view reconstruction, Image based lighting and rendering

Barbara London and John Upton, “Photography". , Pearson, 2013
Szeliski, Richard. Computer Vision: algorithms and Applications. 2nd ed. Springer Nature, 2022.
Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", Cambridge University Press, ISBN: 0521540518, 2004
David Forsyth and Jean Ponce, "Computer Vision: A Modern Approach, Pearson Education, 2011
Foundations of 3D computer graphics by Steven J. Gortler - - Cambridge MIT Press 2012
Rafael Gonzalez and Richard Woods, "Digital Image Processing, third edition Pearson Education India, 2009

AI406N SENTIMENT ANALYSIS (3-0-0) 3

Introduction to Sentiment, Subjectivity, and Stance; Overview, From Words to Discourse & Pragmatics, From Text to Tweets to Speech, Joint Models, Recognizing Stances, Arguments, and Viewpoints, Lexicon-based approaches to sentiment analysis, Exploiting dictionaries, Ontologies, Specialized corpora for detecting the sentiment polarity in texts, Machine learning approaches to sentiment analysis, Sentiment and polarity detection as a classification problem. Polarity evaluation, Affect and emotion detection in texts, Exploitation of multimodal data in combination with text to detect the language of emotions, Emotions and Sentiments in LLM, Applications and case studies.

Bo Pang and Lillian Lee, Opinion mining and sentiment analysis, Foundations and Trends in Information Retrieval 2(1-2), pp. 1-135, 2008.
Bing Liu, Sentiment Analysis and Opinion Mining, Morgan and Claypool Publishers, 2012.
Bing Liu, Sentiment Analysis: Mining Opinions, Sentiments, and Emotions - Cambridge University Press, 2015
Daniel Jurafsky and James Martin. (J&M), Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 2nd edition, 1999

AI407N ADVANCED DATABASE SYSTEMS (3-0-0) 3

Design of database kernels, Schema integration, Data warehousing, Distributed database design, distributed query processing, Distributed transaction processing, Object-Relational databases, Emerging database technologies and applications, Application of conceptual and physical design to the real-world database problems, Multimedia databases, Spatio-temporal databases, Research Trends.

M. Tamer Özsu, Principles of Distributed Database Systems, Prentice Hall, 2011.
Ceri S and Pelagatti G, Distributed Databases: Principles and Systems, McGraw-Hill, 2009.
T Connolly and C Begg, Database Systems: A Practical Approach to Design, Implementation and Management, Pearson, 2015.
R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, Addison-Wesley, 3rd ed., 2011.
R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw-Hill, 3rd ed., 2014.
M. Stonebraker and J. Hellerstein, Readings in Database Systems, Morgan Kaufmann, 4th ed., 2005.
M. Stonebraker, Dorothy Moore, Object-Relational DBMSs, Morgan Kaufmann, 2nd ed., 1998.
J. Han, M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, 3rd ed., 2012.

AI408N PATTERN RECOGNITION (3-0-0) 3

Introduction to Model Selection, Decision Theory, Information Theory; Linear Models for Regression and Classification, Neural Networks: Network Training, Jacobian/Hessian Matrices, Regularization, Mixture Density Networks, Bayesian Networks; Computational Learning Theory, Kernel Methods, Sparse Kernel Machines, Graphical Models, Markov Random Fields, Expectation Maximization, Approximate Inference, Factorized Distributions, Expectation Propagation, Hidden Markov Models, Linear Dynamical Systems, Hybrid Model Construction- Boosting, Tree-based models, Conditional Mixture Models, Q-learning and Policy Gradient, PR Applications.

Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2006.
Duda, Hart, and Strok, Wiley, Pattern Classification, latest edition.
Theodoridis, Sergios, Koutroumbas, Konstantinos, Pattern recognition, Elsevier, 2008.
Heaton, Jeff, Heaton, Introduction to Neural Networks,2nd edition, 2008
Narasimha Murthy and Susheela Devi, Pattern Recognition, (Univeristies Press, 2011)

AI409N AI IN HEALTHCARE (3-0-0) 3

Introduction to medical informatics, Healthcare data sources and basic analytics, Electronic Health Records, Coding Systems, Modalities - Biomedical image analysis, Genomic data analysis, Natural Language

Processing and Data Mining for Clinical Text, mining information from clinical text, dealing with medical terminology, MeSH, SNOMED- CT, Advanced Clinical Data Analytics – Clinical Prediction models, supervised and unsupervised applications, Survival models, evaluations and validation, temporal analytics for clinical data, visual analytics for clinical data, Pervasive health, Clinical Decision Support Systems, Towards explainable-AI in medicine, Applications of Big Data and ML in Medical Diagnostics, Case studies and state-of-the-art systems.

Healthcare Data Analytics (Chapman & Hall/CRC Data Mining and Knowledge Discovery Series) Hardcover – Chandan K. Reddy and Charu C. Aggarwal, CRC Press (2015)
Healthcare Information Management Systems: Cases, Strategies, and Solutions - Charlotte A. Weaver, Marion J. Ball, et al. 2015
Medical Informatics, e-Health: Fundamentals and Applications - Alain Venot, Anita Burgun, et al. 2016
Medical Informatics: Computer Applications in Health Care and Biomedicine - Edward H. Shortliffe and Leslie E.

AI410N SPEECH PROCESSING (3-0-0) 3

Introduction to speech processing, Digitization and Recording of speech signal, Digital Signal Processing Concepts; Time domain & frequency domain, Spectrograms, Knowledge sources at segmental, subsegmental and supra-segmental (prosodic) levels, excitation source, vocal tract system and higher-level knowledge sources and linguistic and semantic knowledge; Pattern recognition, feature extraction, Modelling, testing;

Speech recognition: Objective, issues, block diagram description, classification, Vector quantization, Hidden Markov models, Gaussian mixture models, universal background model (UBM-GMM), Neural networks for building speech technologies NN for Acoustic Modelling – Hybrid modelling- Hybrid-NN: DNN,CNN,TDNN; Issues in speech recognition, Isolated word recognition, Connected word recognition, Continuous speech recognition, Large vocabulary continuous speech recognition; Issues in speaker recognition, Speaker verification vs identification, Text-dependent vs text-independent speaker recognition, Development of speaker recognition systems; Speech data storing standards, Research trends in Speech Technology

L R Rabiner, B-H Juang and B Yegnanarayana, " Fundamentals of Speech Recognition& quot; Pearson, 2009 (Indian subcontinent adaptation).
Xuedong Huang, Alex Acero, Hsiao-wuen Hon, & quot; Spoken Language Processing: A guide to Theory, Algorithm, and System Development & quot; Prentice Hall PTR, 2001.
D. O'Shaughnessy, Speech Communications: Human and Machine, Second Edition, University Press, 2005.
J. Benesty, M. M. Sondhi and Y. Huang, "Handbook of speech processing", Springer,2008.
IEEE/ACM Transactions on Audio, Speech and Language Processing

AI411N GPU COMPUTING (3-0-0) 3

Introduction: History, Architecture, CPU/GPU comparison, Hardware overview, Data parallel execution models: threads, blocks, grids, Warps, Memory hierarchy, Memory Access Coalescing,

Synchronization. Programming models: Compute Unified Device Architecture (CUDA), OpenCL &

Alternatives, Parallel Algorithms and Patterns, Performance Optimization, Case studies.

David Kirk and Wen-mei Hwu, Programming Massively Parallel Processors: A Hands-On Approach, 2nd Edition, Publisher: Morgan Kaufman, 2012.
Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, Morgan Kaufman; 2012.
Ralph Edwards, Mastering GPU Computing with CUDA: High-Performance Parallel Programming for MachineLearning, Data Science, and Deep Learning, 2025

AI412N EDGE AI (3-0-0) 3

Introduction to Edge Computing, Edge hardware and platform: Raspberry Pi, NVIDIA Jetson, Google Coral, Qualcomm AI Engine, Arduino IDE and Programming on the Arduino Nano BLE Development Board, System Architectures for Edge AI, Hardware Constraints, Accelerators: Model Optimization for edge deployment, Pruning Techniques and Tools, Need for compression techniques, Communication and Computation modes for Edge AI, Edge AI Software Frameworks and Libraries, Lightweight models for Edge devices, Knowledge Distillation for Lightweight Models, Convolutional Neural Networks (CNNs) for Edge AI, Real-Time Inference and Streaming on Edge, Deployment of Edge AI Systems, Working principles of the TinyML system, Edge Optimization using AI.

Xiaofei Wang, Yi Pan, Edge AI: Machine Learning for Embedded Systems, Springer, 2022
Daniel Situnayake, Ian Buckley, Practical TinyML: Deploying Machine Learning on Microcontrollers with TensorFlow Lite, O'Reilly Media, 2022

AI413N SMART SYSTEMS DEVELOPMENT (3-0-0) 3

Introduction to Smart Systems, need, Architecture, Infrastructure, Design challenges, Research Challenges. Fundamentals of Smart Infrastructure. Smart Cities, Smart Mobility. Challenges, Architecture, Design of systems in Smart Transportation, Smart Building and Home Devices, Smart health, Smart Government, Smart Energy and Water. Cybersecurity, safety and privacy for smart cities, Applications of IoT, Blockchain, AI and virtual reality in Smart environments.

Carol L. Stimmel, Building Smart Cities: Analytics, ICT, and Design Thinking, CRC press 2015 Lukas Neckermann, Smart Cities, Smart Mobility: Transforming the Way We Live and Work, 2017
Houbing Song, Ravi Srinivasan, Tamim Sookoor, Sabina Jeschke, Smart Cities: Foundations, Principles, and Applications, 2017, Wiley
Amitabh Satyam and Igor Calzada, The Smart City Transformations: The Revolution of The 21st Century, Bloomsbury 2017.

AI414N INDUSTRY 5.0 (3-0-0) 3

Introduction to smart manufacturing, Digitalisation and the Networked Economy; Drivers, Enablers, Compelling Forces and Challenges for Industry 5.0, Driving technologies - Internet of Things (IoT), Industrial Internet of Things (IIoT), Internet of Services, Numerical control (NC), NC programming, Robot programming and PLC, Process plan representation models (for automation), Cyberphysical Systems, Robotic Automation and Collaborative Robots, Cyber Security for smart Industry systems, Autonomous Decision Support Systems for Industry 5.0, Predictive Analytics, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation, Case studies – Toyota, Autoliv, Tesla Production Systems, Mega Factories, Digital twin, Extended reality, Smart City case studies.

Industry 5.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress Publishers 2017
Enterprise IoT: Strategies and Best Practices for Connected Products and Services - Dirk Slama, Frank Puhlmann, Jim Morrish, Rishi M. Bhatnagar, O-Reilly Media (2015)
Hands-On Industrial Internet of Things Paperback - Giacomo Veneri Antonio Capasso

AI415N QUANTUM CRYPTOGRAPHY (3-0-0) 3

Introduction to Quantum Computation: Quantum bits, Bloch sphere representation of a qubit, multiple qubits, XOR of Bit sequence, design of quantum circuits, Introduction to Cryptography, Cryptography with XOR, Shared Secret, Importance of Randomness, Breaking the Code, Comparison between classical and quantum information theory, Bell states, Quantum teleportation, Principles of Quantum Cryptography, Quantum key distribution, Single photons, EPR pairs, no cloning theorem. Quantum Algorithms, BB84 Protocol, Error Correction: Graph states and codes, Quantum error correction, fault- tolerant computation.

Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. II, Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
Pittenger A. O., An Introduction to Quantum Computing Algorithms
Bellac Michel Le, "A short introduction to quantum information and quantum computation", Cambridge University Press, 2006
N. David Mermin, "Quantum Computer Science", Cambridge University Press, 2007.

AI416N DIGITAL FORENSICS (3-0-0) 3

Introduction, The Scope of Computer Forensics, Windows Operating and File Systems, Handling Computer Hardware, Acquiring Evidence in a Computer Forensics Lab, Online Investigations, Documenting the Investigation, Admissibility of Digital Evidence, Network Forensics, Mobile Forensics, Photograph Forensics, Mac Forensics. Database forensics: forensic study of databases and their metadata. Investigative use of database contents, log files and in-RAM data in order to build a time-line or recover relevant information. Mobile device forensics: recovery of digital evidence or data from a mobile device. Media Analysis: disk structure, file systems (NTFS, EXT 2/3, HFS), and physical layer issues; Tools for digital forensics. Analysis Techniques: keyword searches, timelines, hidden data; Application Analysis; Network Analysis; Analysis of Cell phones, PDAs, etc.; Binary Code Analysis; Evidence: collection, preservation, testimony.

Dr. Darren R. Hayes, A Practical Guide to Computer Forensics Investigations, Pearson Publisher, 2015.
Kanellis, Panagiotis, Digital Crime and Forensic Science in Cyberspace. IGI Publishing, 2006.
Jones, Andrew, Building a Digital Forensic Laboratory. Butterworth- Heinemann, 2008. ISBN 1856175103.
Marshell, Angus M. Digital Forensics: Digital Evidence in Criminal Investigation. John Wiley & Sons; 2009.
Philip Craiger, Sujeet Shenoi, Advances in Digital Forensics in, Springer, 2007.
Paul Crowley Dave Kleiman, CD and DVD Forensics, Syngress Publishing Inc, 2007.
Chris Prosise, Kevin Mandia, Incident Response & Computer Forensics, McGraw-Hill, 2 nd Edition, 2003.

AI417N AUTONOMOUS CYBER PHYSICAL SYSTEMS (3-0-0) 3

CPS architecture. Overall architecture for CPS. Mobile sensing devices and platforms for CPS. Naming, addressing, and profile services for CPS. Device search and selection for CPS. Energy management for CPS. Enabling technologies for CPS. Networking technologies for CPS. Machine-to-machine communications for CPS. Mobile cloud computing for CPS. CPS applications. Connected healthcare for CPS. Multi-player gaming for the public transport crowd. Mobile cloud computing enabled emerging CPS applications.

Chi (Harold) Liu, Yan Zhang, Cyber Physical Systems: Architectures, Protocols and Applications, 1st Edn, CRC Press, 2019.
Rajeev Alur. Principles of Cyber-Physical Systems. The MIT Press, 2015.
K. J. Astrom and R. M. Murray. Feedback Systems: An Introduction for Scientists and Engineers. Prince- ton University Press, 2009.
C. Baier and J.-P. Katoen. Principles of Model Checking. The MIT Press, 2008.
H. Choset, K. M Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun. Principles of Robot Motion: Theory, Algorithms, and Implementations. MIT Press, 2005.
S. M. LaValle. Planning Algorithms. Cambridge University Press, 2006.
Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, 2015.

AI418N GENERATIVE AI (3-0-0) 3

Introduction to Generative Models: Understanding the difference between Generative and Discriminative models; GANs and Variational Autoencoders (VAEs) - Transformers -BERT - LLM foundation; AI Safety Primer and Representation Engineering; Deep Learning Frameworks Design Principles - Pre-trained LLMs - Tokenization and Decoding; Model Quantization and Compression; Prompt tuning -Efficient fine-tuning of

LLMs - LoRA - QLoRA; Memory Optimization for LLMs; Retrieval-augmented Language Models; Multimodal LLMs; Security of LLMs. Evaluation of LLM. Gen AI Tools - Applications and new trends in LLM.

Raschka, Sebastian. Build A Large Language Model (From Scratch). Manning, 2024.
Jay Alammar, & Maarten Grootendorst. Hands-On Large Language Models. O'; Reilly, 2024.
Chakraborty, T. Introduction to Large Language Models: Generative AI for Text. Wiley, 2024.

AI419N RESPONSIBLE AI (3-0-0) 3

Fundamentals of Responsible AI (RAI): Introduction to ethical, legal, and social issues in AI; safety, reliability, and human-centered design principles; Fairness and Bias Mitigation: Sources of data bias, group vs. individual fairness, and pre/in/post-processing techniques to remove bias; Interpretability and Explainability (XAI): Intrinsically interpretable models, post-hoc explanation methods (LIME/SHAP), and model-agnostic interpretation; Privacy-Preserving Technologies: Privacy attacks on models, differential privacy, and federated learning; Accountability and Governance: Auditing AI models, legal frameworks for AI (Indian/global), and ethical AI deployment strategies; Responsible GenAI/LLMs: Addressing toxicity, hallucinations, prompt engineering risks, and robust guardrails.

Dignum V. Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way. Springer Nature, 2019.
Christoph Molnar. Interpretable Machine Learning: A Guide for Making Black Box Models Explainable, 2020.
Christian B. The Alignment Problem: Machine Learning and Human Values. WW Norton & Company, 2020.
Anderson M, Anderson SL. Machine Ethics. Cambridge University Press, 2011.
Coeckelbergh M. AI ethics. MIT Press, 2020.
Bostrom NS. Superintelligence: Paths, Dangers, Strategies. Oxford University Press, 2014.

AI420N APPLIED ALGORITHMS (3-0-0) 3

Sequential algorithms. Preliminaries: Algorithmic design techniques and representative problems. Combinatorial algorithms. Graph algorithms. String matching algorithms, External memory algorithms, online algorithms, algebraic and number theoretic algorithms and Security & Cryptography algorithms. Several other categories of algorithms. Design and analysis of Parallel algorithms, Problem reduction. Basics of randomized algorithms, and randomized algorithms, application of randomness for correctness verification. Hardness and basics of Approximation algorithms.

Alfred V Aho, John E Hopcroft, Jeffery D Ullman, Data structure and algorithms, Addison Wesley, 1993.
J. Kleinberg, E. Tardos, Algorithm design. Pearson Education, Addison Wesley, 2006.
Michael Jay Quinn, Designing efficient algorithms for parallel computers, McGraw Hill 1997.
Rajeev Motwani, PrabhakarRaghavan, Randomized algorithms, Cambridge University Press, 1995.
R. E. Tarjan, Data structures and network algorithms, SIAM, 1983.
Vijay V. Vazirani, Approximation algorithms, Springer, 2001.

AI421N RANDOMIZED ALGORITHMS (3-0-0) 3

Randomness and algorithms. Deterministic vs Randomized algorithms. Monte Carlo and Las-Vegas algorithms. Advantages of Randomized algorithms. Basic principles for the construction of randomized algorithms. Motivation: Game Tree Evaluation. Tools and Techniques; Basic probability theory; randomized complexity theory; game-theoretic techniques, etc. Randomized algorithms for the problems in various domains viz., Graph algorithms, Geometric algorithms, parallel and distributing algorithms, online algorithms, Number theory and algebra. etc., coupon collection and occupancy problems; Markov chains and random walks; stable distributions; probability amplification and derandomization. Applications: Sorting and searching; data structures; combinatorial optimization and graph algorithms; metric embeddings; online and streaming algorithms; algorithms for massive data sets including similarity search, nearest neighbours, and clustering; number- theoretic algorithms.

Motwani and Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
Mitzenmacher and Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press, 1995.
William Feller, An introduction to Probability Theory and Its Applications, Volumes I and II, John Wiley, New York, 1968.
J. Hromkovic, Design and Analysis of Randomized Algorithms, Springer 2005.

AI422N APPROXIMATION ALGORITHMS (3-0-0) 3

Basics and definitions related to Approximation Algorithms; Greedy Algorithms (Set cover and Vertex Cover); Combinatorial Algorithms (Traveling Salesman Problem and Steiner Tree); Dynamic Programming and Rounding (Knapsack and Bin Packing); LP-based Algorithms: Randomized and Deterministic Rounding, Dual-Fitting, Primal-Dual Schema; Cuts and Metrics (Multicut, Multiway Cut, Max Cut, Sparsest Cut); SDP (Max Cut and Coloring); Geometric Approximation Algorithms (Geometric Set Cover, Hitting Set, Independent Set of Rectangles): Greedy, Shifted-Grid, Quad-Trees, Geometric Separators, Local Search; Sum of Squares; Hardness.

Vijay V. Vazirani. Approximation Algorithms, Springer, 2001
David P. Williamson & David B. Shmoys. The Design of Approximation Algorithms, Cambridge University Press, 2011
Ding-Zhu Du, Ker-I Ko, Xiaodong Hu. Design and Analysis of Approximation Algorithms, Springer, 1997
Dorit S. Hochbaum (Ed.). Approximation Algorithms for NP-Hard Problems, PWS Publishing, 1997.

AI423N PRIVACY PRESERVING MACHINE LEARNING (3-0-0) 3

Motivation for privacy in ML, Data privacy regulations: GDPR, HIPAA, CCPA. Introduction to Data Privacy, Privacy Breaches, and Threat models in machine learning. Privacy-Preserving Data Analysis and an Introduction to Differential Privacy, Machine Learning Phases and Privacy Threats/Attacks in Each Phase. Types of privacy: Data privacy, model privacy, inference privacy, Introduction to privacy metrics. Anonymisation, pseudonymization, k-anonymity. Concept of differential privacy, Mechanisms: Laplace and Gaussian noise, DP in ML: DP-SGD, Privacy-accuracy trade-off. Federated Learning (FL): Centralized vs. decentralized learning, Federated averaging (FedAvg), Communication and convergence challenges, Split learning. Secure Multi-Party Computation (SMPC), Trusted Execution Environments, Attacks on ML Privacy: Model inversion attacks, Membership inference attacks, Data poisoning & defenses, Case Studies & Applications: Healthcare: Predicting disease without sharing patient data, Finance: Fraud detection, Mobile & IoT applications, Real-world deployment challenges.

Cynthia Dwork & Aaron Roth. The Algorithmic Foundations of Differential Privacy. Now Publishers, 2014
Qiang Yang, Yang Liu, Tianjian Chen & Yongxin Tong. Federated Machine Learning: Concept and Applications. ACM (TIST journal), 2019
Srinivasa Rao Aravilli. Privacy-Preserving Machine Learning: Principles and Techniques. Packt / O'Reilly, 2024
Ian Goodfellow, Yoshua Bengio & Aaron Courville. Deep Learning. MIT Press, 2016
Nigel Smart. Cryptography Made Simple. Springer, 2016

AI424N TRUSTWORTHY MACHINE LEARNING (3-0-0) 3

Introduction to trustworthy machine learning: Machine learning in the presence of an adversary, Responsible and trustworthy AI. Robustness: Inference in the adversarial setting, Robust inference in the adversarial setting -Various (failed) attempts to build robust models, Adversarial training, Certified robustness using randomized smoothing, Learning in the adversarial setting -Introduction to data poisoning attacks, Influence of training data on models, Methods for designing poisoning data, Backdoor attacks. Quantitative reasoning about data privacy in machine learning. Fairness: Bias in machine learning-Sources and types of bias in machine learning, Formal definitions of fairness, Satisfying fairness criteria in machine learning -Methods for achieving group fairness, Limitations and tradeoffs, Open issues and advanced topics. Federated

learning: Robustness and Fairness -Poisoning attacks in federated learning, Robust federated learning, Bias and fairness in federated learning.

Cynthia Dwork and Aaron Roth. The algorithmic foundations of differential privacy. Foundations and Trends in Theoretical Computer Science 9, 2014.
Solon Barocas, Moritz Hardt, and Arvind Narayanan. Fairness and machine learning: Limitations and Opportunities. Work in progress book, 2019.

AI425N ADVANCED ALGORITHMS (3-0-0) 3

Advanced Divide and Conquer, Greedy, Dynamic Programming, branch and bound algorithms. Combinatorial algorithms, Number theoretic algorithms, Network flow, linear programming, randomised algorithms, parallel algorithms, Online algorithms, Streaming algorithms, String algorithms, Linear programming, Hard Problems, Approximation algorithms, network optimization.

Jon Kleinberg, Éva Tardos – Algorithm Design, Pearson, 2005 (1st ed).
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein – Introduction to Algorithms, MIT Press, 2022
Robert Sedgewick, Kevin Wayne – Algorithms, Addison-Wesley Professional, 2011
Steven S. Skiena – The Algorithm Design Manual, Springer Cham, 2020
Sanjoy Dasgupta – Algorithms, McGraw-Hill,2011
Dimitri P. Bertsekas, John N. Tsitsiklis – Parallel and Distributed Computation: Numerical Methods, Athena Scientific, 2015
C. Xavier, S. S. Iyengar – Introduction to Parallel Algorithms, Wiley, 1998

AI426N ADVANCED DATA STRUCTURES (3-0-0) 3

Mathematical & Computational Foundations, Balanced Search Trees, Multiway & External Memory Trees, Self-Adjusting Trees, Heaps and Priority Queues, Applications in Graph algorithms, Range Query Data Structures, Advanced Graph Data Structures, String Data Structures, Suffix Trees, Geometric Data Structures, Persistent & Functional Data Structures, Randomised & Probabilistic Structures.

Niklaus Wirth – Algorithms + Data Structures = Programs, Prentice-Hall, 1976
Robert E. Tarjan – Data Structures and Network Algorithms, SIAM, 1983
Donald E. Knuth – The Art of Computer Programming, Vols. 1–3, Addison-Wesley, 2015
Chris Okasaki – Purely Functional Data Structures, Cambridge University Press, 1998
Dinesh P. Mehta, Sartaj Sahni (eds.) – Handbook of Data Structures and Applications, 2nd Ed., Chapman & Hall/CRC, 2018
Mark Allen Weiss – Data Structures and Algorithm Analysis (advanced versions),2022
Marcello La Rocca – Advanced Algorithms and Data Structures, Manning, 2021

AI427N POST QUANTUM CRYPTOGRAPHY (3-0-0) 3

Motivation for Post Quantum Cryptography. Quantum threats to hard problems. Basics of error correcting codes, Goppa codes, Introduction to lattices, Useful Lattice Problems, hard problems. Lattice-based cryptography, Regev encryption, ring-SIS, ring LWE, NTRU preliminaries, Kyber, NTRU, Dilithium and FALCON cryptosystems. Code-based cryptography, McEliece public-key cryptosystem, decoding attacks against McEliece, multivariate cryptography, Rainbow cryptosystem, hash-based cryptography, One-time Signature, Isogeny Cryptography.

Daniel J. Bernstein, Johannes Buchmann, Erik Dahmen-Post-quantum cryptography, Springer, 2009
Quantum Computation and Quantum Information by Nielsen and Chuang
NIST Post Quantum Standardization

AI428N SECURE MULTIPARTY COMPUTATION (3-0-0) 3

Basic concepts of Cryptography, Basics of Secure Multi-Party Operations, Secret Sharing, Garbled Circuits, Oblivious Transfers, Perfectly-Secure MPC for Small Number of Parties, Yao's Protocol for Secure 2-party Computation, The BGW Perfectly-Secure MPC Protocol for Linear Functions, The BGW Perfectly-Secure MPC Protocol for Any Arbitrary Function, Homomorphic Encryption, and Zero-Knowledge Proofs, Secure Multiparty Summation, Secure Multiparty Comparison, Secure Function Evaluation, Secure Set Intersection, Secure Matrix Multiplication, Secure Machine Learning Algorithms, Privacy-Preserving Data Analytics, Collaborative Machine Learning and Model Training, Private Information Retrieval.

Carmit Hazay & Yehuda Lindell. Efficient Two-party Protocols: Techniques and Constructions, Springer-Verlag, 2010.
Ashish Choudhury, Arpita Patra-Secure Multi-Party Computation Against Passive Adversaries, Springer, 2024
Thomas Schneider. Engineering Secure Two-party Computation Protocols, Springer-Verlag, 2010.
Ronald Cramer, Ivan Damgård & Jesper Buus Nielsen. Secure Multiparty Computation and Secret Sharing, Cambridge University Press, 2015.

AI429N PRIVACY PRESERVING DATA PUBLISHING (3-0-0) 3

Data Collection and Data Publishing, Anonymisation, Information Metrics, Attack Models and Privacy models: Record linkage model, attribute linkage model, Table linkage model, probabilistic model, modelling adversary's background knowledge, Anonymization operations and algorithms, Anonymization for data mining Anonymizing transaction data, Anonymizing Social Networks, One-time data publishing, Multiple time data publishing, Graph data and other data types.

Benjamin C.M. Fung, Ke Wang, Ada Wai-Chee Fu, and Philip S. Yu, Introduction to Privacy-Preserving Data Publishing: Concepts and Techniques, Chapman & Hall/CRC,2010.
Raymond Chi-Wing Wong, Ada Wai-Chee Fu, Privacy-Preserving Data Publishing: An Overview, Springer, 2022.

AI430N PATH PLANNING (3-0-0) 3

Introduction and Configuration Space: Definition of path planning, obstacle avoidance, goal attainment, Free space, obstacle space, Grid mapping, cell decomposition, and topological maps; Graph Search-Based Algorithms: Dijkstra's algorithm, (A-star) algorithm, (D-star) Lite; Visibility Graphs: Constructing shortest paths in polygonal environments; Sampling-Based Algorithms: Probabilistic Roadmaps (PRM), Rapidly- exploring Random Trees (RRT), Optimal Sampling-Based Planners: RRT*, PRM*, Kinodynamic Planning: Considering robot dynamics; Local Path Planning and Reactive Methods: Bug Algorithms, Artificial Potential Field (APF), Dynamic Window Approach (DWA), Vector Field Histogram (VFH), Advanced Path Planning: Bio-inspired Algorithms: Genetic Algorithm, Ant Colony Optimization, Particle Swarm Optimization, Learning-based Approaches: Deep Reinforcement Learning (DRL) for path planning, Hybrid Approaches; Trajectory Planning and Smoothing.

LaValle, Steven M. Planning Algorithms. Cambridge: Cambridge University Press, 2006.
Thrun, S., Burgard, W., & Fox, D. Probabilistic robotics. MIT Press, 2005.
Klančar, G., Zdešar, A., Blažič, S., & Škrjanc, I. Wheeled mobile robotics: From fundamentals towards autonomous systems. Butterworth-Heinemann, 2017.
Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G. A., Burgard, W., Kavraki, L. E., & Thrun, S. Principles of robot motion: Theory, algorithms, and implementations. MIT Press, 2005.

AI431N HARDWARE PLATFORMS FOR AI (3-0-0) 3

Compute-Centric: Computational requirements for AI, FLOPS analysis and computational intensity, SIMD and multithreading concepts, Latest industry GPU, TPU, and NPU architectures and deployment models,

Deployment of AI models on microcontrollers and microprocessors (Arduino, ESP32, and Raspberry Pi), FPGA-based AI acceleration, ASIC devices for AI, MLPerf evaluation standards, Generic AI development tools and frameworks, Memory Centric: Von Neumann bottleneck, Roofline model and memory bandwidth analysis, Data-centric training platforms and large-scale AI infrastructure, Embedded AI platforms, Edge AI systems and TinyML for memory-limited environments

J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, 7th ed. Burlington, MA, USA: Morgan Kaufmann (Elsevier), 2025.
V. Sze, Y.-H. Chen, T.-J. Yang, and J. S. Emer, Efficient Processing of Deep Neural Networks: A Tutorial and Survey. Cham, Switzerland: Springer, 2020.
P. Warden and D. Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers. Sebastopol, CA, USA: O'Reilly Media, 2020.
D. X. Liu (Ed.), High-Level Synthesis for FPGA-Based Accelerators. Cham, Switzerland: Springer, 2019.

AI432N TIME SERIES ANALYSIS (3-0-0) 3

Stationary processes, ensemble, random walk Vs trend, periodicity, linear process; Estimators mean, ACF, PACF, variogram; Properties covariance , normality ; Regression , models for trend, differencing, backshift operator ; Harmonic regression, periodogram, signal processing; Nonparametric regression, smoothing, periodic functions; Model selection, AIC, BIC, SIC, bias-variance trade-off; ARMA models; Estimation , MLE, LS, forward-backward ; State- space models ,Kalman filter, hidden state, HMM, Switching models, hidden Markov models (HMM), GARCH, stochastic volatility, financial models; Heteroscedasticity, Wavelets Vector Autoregressive (VAR) Models, Integrated Variables and Cointegrated VAR Models, Time-varying parameter and Bayesian VARs, Multivariate GARCH Models

Shumway, R.H. and Stoffer, D.S., Time Series Analysis and its Applications: With R Examples, Springer.
Pole A., West M. and Harrison P.J., Applied Bayesian Forecasting and Time Series Analysis. Chapman-Hall.
Tsay, R. S. Analysis of Financial Time Series, John Wiley and Sons.
West, M. and Harrison, P.J. (1997), Bayesian Forecasting and Dynamic Models, Springer-Verlag.

AI433N BIG DATA ANALYTICS (3-0-0) 3

Introduction– distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Algorithms using map reduce, Apache Hadoop & Hadoop EcoSystem, Data Serialization, HDFS, Hive Architecture, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Schema Design, Advance Indexing, PIG, Zookeeper , Data Analysis with Spark, Programming with RDDs, Machine Learning with MLlib, NoSQL, NewSQL, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents, MongoDB Query Language, Big data analytics, Big data applications.

Understanding Big data, Chris Eaton, Dirk derooset al, McGraw Hill, (2017)
Big Data and Analytics, 2ed, Subhashini Chellappan Seema Acharya, Wiley (2019)
Big Data: Principles and Best Practices of Scalable Real-Time Data Systems - Nathan Marz and James Warren, Manning Publishers (2015)

AI434N INTERNET OF THINGS (3-0-0) 3

Principles and foundation of IoT: Reference Models, Platforms, Big data and IoT, Relevance of AI in IoT. IPv6 packet. Communication standards for IoT: IEEE 802.15.4, IEEE 802.11, 6LoWPAN. Routing in IoT, Standards for IoT, 5G. Service Oriented architecture, The Constrained Application Protocol (CoAP) and MQTT: features, interaction model, messages and request and response sub layer. Application of AI in IoT.

Amita Kapoor, Hands on Artificial Intelligence for IoT, Packt, 2019
J. Biron and J. Follett, Foundational Elements of an IoT Solution, O'Reilly Media, 2016. Keysight Technologies, The Internet of Things: Enabling Technologies and Solutions for Design and Test, Application Note, 2016.

Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, Apress, 2013 Arshdeep Bahga and Vijay Madisetti, Internet of Things: A hands on approach, VPT Publications 2014
Olivier Hersent, David Boswarthick, Omar Elloumi, The IoT: Key Applications and Protocols, Wiley, 2015.

AI435N BLOCKCHAIN TECHNOLOGY (3-0-0) 3

Blockchain Architecture, P-2-P Networks, Blockchain Networks, Transaction Life Cycle, Role of Miners in Blockchain Technology, Consensus Algorithms, Proof of Work, Proof of Stake, Proof of Elapsed Time, Round Robin-Advantages and Disadvantages, Candidate Blocks, Blockchain Technology and Artificial Intelligence, IoT and Blockchain: Challenges and Risks, Introduction to Blockchain and IoT, Challenges of Blockchain in IoT, Risks of using Blockchain in IoT, The optimum Secure IoT Model, Blockchain in Intelligent Vehicles, Blockchain Technology for Supply Chain Insight from Enterprise Resource Planning, Next Generation Blockchain Enterprise Artificial Intelligence System, Artificial Intelligence and Deep Learning Chains, Blockchain Technology Use Cases in Health Care, Blockchain Technology Use Case in Smart City Applications. Blockchain Hands on for generating Genesis Block.

"Adv Apps of Blockchain Technology", Shiho Kim and Ganesh Chandra Deka, Springer, 2019, (Available Online)
Blockchain Technology: Platforms, Tools and Use Cases "Advances in Computers Volume 111, Ali R Hurson and Atif M. Memon, Academic Press, 2019.
Ahmed Banafa, "Secure and Smart Internet Of Things (IoT) using Blockchain and Artificial Intelligence", 2018

AI436N CAUSAL INFERENCE (3-0-0) 3

Foundations of Causality, Structural Causal Models, Intervention & Do-Calculus, Counterfactual Reasoning, Causal Inference from Data, Causal Discovery, Causality in Machine Learning & Deep Learning, Applications & Emerging Trends, Advanced Topics.

Pearl J, Causality: Models, Reasoning, and Inference, Cambridge University Press, 2000.
Pearl J, Mackenzie D. The Book of Why.
Peters J, Janzing D, Scholkopf B. Elements of Causal Inference: Foundations and Learning Algorithms. MIT press; 2017.

AI398N/ AI448N/ AI498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

AI399N MAJOR PROJECT - I (0-0-18) 9

AI449N MAJOR PROJECT - II (0-0-18) 9

AI499N MAJOR PROJECT - III (0-0-18) 9

Department of Mathematical and Computational Sciences (MA)
Bachelor of Technology in Computational and Data Science

Basic Sciences Courses (BSC) - 20 Credits

PH150N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
MA107N	Multivariable Calculus	(3-0-0)3
MA102N	Series and Ordinary Differential Equations	(3-0-0)3
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC) - 12 Credits

CS100N	Computer Programming (C)	(0-0-6)3
UC101N	Introduction to Engineering	(2-0-2)3
UC100N	Data Science and AI	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC) - 20 Credits

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC) - 51 Credits

MA200N	Linear Algebra	(2-1-0)3
MA201N	Probability Theory and Stochastic Processes	(2-1-0)3
MA202N	Introduction to Optimization	(2-1-0)3
MA203N	Data Structures	(2-0-2)3
MA204N	Computer Organization and Architecture	(2-0-2)3
MA205N	Discrete Mathematical Structures	(2-1-0)3
MA250N	Linear Systems and Integral Transforms	(2-1-0)3
MA251N	Design and Analysis of Algorithms	(2-0-2)3
MA252N	Statistical Inference	(2-1-0)3
MA253N	Machine Learning	(2-0-2)3
MA254N	Foundations of Data Science	(2-1-0)3
MA255N	Data Analytics and Visualization	(2-0-2)3
MA300N	Systems and Databases	(2-0-2)3
MA301N	Artificial Intelligence	(2-0-2)3
MA302N	Time Series Analysis	(2-1-0)3
MA303N	Scientific Computing	(2-1-0)3
MA304N	Deep Learning	(2-0-2)3

Internships/Major Project Courses (IPC) - 27 Credits

MA398N	Internship - I	(0-0-18)9
MA399N	Major Project - I	(0-0-18)9
MA448N	Internship - II	(0-0-18)9
MA449N	Major Project - II	(0-0-18)9
MA498N	Internship - III	(0-0-18)9
MA499N	Major Project - III	(0-0-18)9

Honors (Hn) - 15 Credits

Students seeking an Honors degree shall credit a minimum of 15 additional credits from Postgraduate courses offered by the respective Department, as decided by the DUGC.

Dept/Institute Elective Courses (DEC) - minimum 20 Credits

MA350N	Bioinformatics	(2-0-2)3
MA351N	Computer Networks	(2-1-0)3
MA352N	Computer Vision	(2-1-0)3
MA353N	Data Mining and Warehousing	(3-0-0)3
MA354N	Natural Language Processing	(2-0-2)3
MA355N	Operating System	(2-1-0)3
MA356N	Soft Computing	(2-1-0)3
MA357N	Theory of Computation	(3-0-0)3
MA400N	Computational Number Theory and Cryptography	(2-1-0)3
MA401N	Graph Models and Algorithms	(2-1-0)3
MA402N	Network Security	(2-0-2)3
MA403N	Pattern Recognition	(2-0-2)3
MA404N	Monte Carlo Simulation	(1-1-2)3
MA405N	Multivariate Statistical Analysis	(2-1-0)3
MA406N	Topological Data Analysis	(2-1-0)3
MA407N	Physics-Informed Neural Networks (PINNs)	(2-1-0)3
MA450N	Digital Image Processing and Coding	(2-1-0)3
MA451N	Digital Video Processing and Coding	(2-1-0)3
MA452N	Operations Research	(2-1-0)3
MA453N	Probabilistic Graphical Models	(2-1-0)3
MA454N	Advanced Data Structures	(2-0-2)3
MA455N	High Performance Computing	(2-1-0)3
MA456N	Financial Mathematics	(3-0-0)3
MA457N	Stochastic Analysis and Applications	(3-0-0)3
MA458N	Game Theory	(3-0-0)3

Suggested Plan of Study for B.Tech. in Computational and Data Science:

Slot/ Semester	I	II	III	IV	V	VI	VII	VIII
1	CY100N	PH150N	MA200N	MA250N	MA300N	MA398N/ MA399N	MA448N/ MA449N	MA498N/ MA499N
2	MA107N	MA102N	MA201N	MA251N	MA301N	Elective 1	Elective 4	Elective 6
3	UC103N	UC102N	MA202N	MA252N	MA302N	Elective 2	Elective 5	Elective 7
4	UC100N	UC101N	MA203N	MA253N	MA303N	Elective 3	Honors/ MA430MN (Optional)	Honors/ MA480MN (Optional)
5	DE100N	CS100N	MA204N	MA254N	MA304N	Honors/ MA380MN (Optional)		
6	PL1XWN/ PL1X9N	PL1YWN/ PL1Y9N	MA205N	MA255N	PL3XWN/ PL3X9N			
7			PL2XWN/ PL2X9N	PL2YWN/ PL2Y9N	Honors/ MA330MN (Optional)			
8				Honors/ MA280MN (Optional)				

Requirements for B.Tech. in Computational and Data Science:

Category of Courses	Minimum Credits to be Earned
Basic Sciences Courses (BSC)	20
General Engineering Courses (GEC)	12
Life Skill Courses (LSC)	20
Programme Core Courses (PCC)	51
Dept/Institute Elective Courses (DEC)	21
Internships/Major Project Courses (IPC)	27
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be Earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be Earned
5	15

Honors: minimum 15 additional credits from Postgraduate courses offered by the Department, as decided by the DUGC.

Minor: minimum 15 credits, subject to the Minor basket finalised by the DUGC.

MA200N LINEAR ALGEBRA (2-1-0) 3

System of linear equations, Gaussian elimination method. LU-factorization, R^n as a vector space. R^n and C^n as vector spaces. Subspaces, spanning set. Linear dependence, Basis. Dimension of subspace of R^n, Linear transformations. Linear transformations, matrix representation. Rank and nullity, Rank-nullity theorem. Inner product on R^n. Orthogonal and orthonormal sets, Gram-Schmidt orthogonalization. Orthogonal Complement, QR-factorization. Eigenvalues, eigenvectors, characteristic polynomials. Cayley-Hamilton Theorem, Diagonalization. Singular value decomposition.

David C Lay. Linear algebra and its applications, 5th Edition. Pearson, 2023.
Gilbert Strang. Introduction to linear algebra. Wellesley-Cambridge Press, 2022.
Ward Cheney, and David Kincaid. Linear algebra: Theory and applications. Jones and Barlett, 2009.
S. H. Friedberg, A. J. Insel, L.E. Spence, Linear Algebra, 4th Edition, Pearson. 2015.

MA201N PROBABILITY THEORY AND STOCHASTIC PROCESSES (2-1-0) 3

Random experiments, sample spaces, events, axioms of probability, Probability spaces. Conditional probability, independence of events, Theorem of total probability, Bayes' theorem and its Applications. Random variables, probability density functions, and cumulative distribution functions. Standard univariate Discrete distributions: Bernoulli, Binomial, Geometric, Poisson. Continuous distributions: Uniform, Exponential, Gamma. Normal distribution, standard normal distribution, Use of standard normal Tables. Mathematical expectation, moments. Moment generating functions, Joint distributions. Marginal distributions, conditional distributions. Functions of random variables, conditional expectation. Chebyshev inequality, law of large numbers, Central limit theorem. Definition and classification of stochastic processes, Markov chains. Classification of states, Stationary distributions.

Limiting behavior of Markov chains, Poisson process, applications.

Ross, Sheldon M. Introduction to Probability Models. Academic Press, 2014.
Castañeda, Liliana Blanco, Viswanathan Arunachalam, and Selvamuthu Dharmaraja. Introduction to probability and stochastic processes with applications. John Wiley & Sons, 2012
J. Medhi, Stochastic Processes, 3rd Ed., New Age International, 2009.
K. S. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, 2nd Ed., Wiley, 2001.
Yates, Roy D., and David J. Goodman. Probability and stochastic processes: a friendly introduction for electrical and computer engineers. John Wiley & Sons, 2014.

MA202N INTRODUCTION TO OPTIMIZATION (2-1-0) 3

Introduction, Types of problems, and existence of optimal solutions. Recap of Gradients, Directional derivatives, Normals to level curves and tangents, Extreme values and saddle points. Local and global minimizers: First and second-order necessary conditions for local minimizers. Convex and concave Functions, Minimization and maximization of convex functions. Line search methods: Golden Section Search, Fibonacci Search. Newton's method. Secant method, Method of steepest descent. Coordinate descent methods, Conjugate gradient methods. Quasi-Newton methods. Linear programming problems and their basic properties. Simplex method. Big-M and Two-Phase methods. Nonlinear constrained optimization problems with equality constraints. Nonlinear constrained optimization problems with inequality constraints. KKT conditions.

D. G. Luenberger and Y. Ye, Linear and Nonlinear Programming, Springer, 4th Edition, 2016
E.K.P. Chong and S.H. Zak, An Introduction to Optimization, Wiley, 3rd Edition, 2011.
S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2009
J. Nocedal and S. J. Wright, Numerical Optimization, Springer, 2006.

MA203N DATA STRUCTURES (2-0-2) 3

Introduction to Object oriented paradigm: Encapsulation, Inheritance. Polymorphism, Abstraction, Objects and Classes. Modularity, Reusability, Maintainability, Scalability, Real-World Modelling using Object oriented programming. Introduction to data structures. Types: Linear and Nonlinear. Abstract Data Types (ADT). Linear Data Structures and their sequential storage representation. Pointers and linked storage representation. Linked storage: singly linked list, circular linked list, doubly linked lists and their applications. Stacks and Queues data structure. Insertion and deletion operations. Searching Techniques: Linear and Binary Search. Time Complexity Analysis: Asymptotic Analysis. Sorting methods: Insertion Sort, Bubble Sort, and Selection Sort and their Time complexity analysis. Application of Sorting. Nonlinear data structures: trees: binary trees, storage representation of binary trees using matrices and linked lists. Operations on binary trees (BTs) and Binary Search Trees (BSTs): tree traversals, Tree creation, insertion, deletion, applications of trees. Binary Heaps/priority queues: Operations on Binary Heaps: Searching, Insertion, Deletion. Heapsort: Best and Worst case analysis. Height Balanced Trees: AVL Trees and the Operations: Insertion, Deletion. B-Trees and their operations. Graphs and Searching: representation of graphs: Adjacency Matrix, Adjacency list., breadth first search and depth first search. Graph Algorithms.

Horowitz and Sahni, "Fundamentals of Data Structures and Algorithms in C++", Universities Press, 2007
A.V. Aho, J.E. Hopcraft and J.D. Ullman, "Data Structures and Algorithms", Pearson Education, 2003.
J.P. Tremblay and P.G. Sorenson, "An Introduction to Data Structures with Application", Tata McGraw-Hill, 1991.
Cormen, Leiserson, Rivest, and Stein, "Introduction to Algorithms", MIT Press, 3rd Edition, 2009.

MA204N COMPUTER ORGANIZATION AND ARCHITECTURE (2-0-2) 3

Introduction to Computer Organization vs Architecture, Functional Units, Von Neumann Model, Hardware–Software Interface, Technologies for Building Processors and Memory. Binary numbers, signed numbers, BCD, ASCII, IEEE 754 floating-point format; Addition and Subtraction, Multiplication and Division Algorithms. Floating Point Representation, Problems, Logic design basics (review), Combinational and sequential circuits. Instruction set architecture (ISA), types (RISC vs CISC), addressing modes, representing Instructions in the Computer. Logical Operations, and Instructions for Making Decisions, MIPS Addressing for 32-Bit Immediates and Addresses. ISA Continued & Parallelism, Instruction pipeline stages, Hazards, Hazard resolution techniques. Performance analysis, CPI, MIPS, Amdahl's law. CPU Design, data path, control unit (hardwired and microprogrammed). Memory hierarchy, RAM types, cache memory, mapping techniques. Virtual memory, paging, page tables, TLB. Input/Output organization, interrupts, DMA. I/O mapped and memory mapped I/O; Bus structures and interconnection systems. Multiprocessors and\multicore architecture, concepts, shared memory, interconnect; Architecture of modern processors.

David A Patterson and John L Hennessy. Computer Organization and Design–The ardware/Software Interface. 4e (ARMEdition), 2012/5e (MIPS Edition), 2014/6e (RISC-VEdition).
W. Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson, 2015.
John. P. Hayes, Computer System Architecture.
Hamacher, Vranesic, Zaky. Computer Organization. 5e. Tata McGraw-Hill. 2011. John P Hayes. Computer Architecture and Organization. 3e. McGraw-Hill. 1998.
Hwang K., Briggs, Computer Architecture and Parallel Processing, 1984.
M.Morris Mano, Computer System Architecture, 3rd Edition, 1993.
David M. Harris and Sarah L. Harris, Reference for some of the assignments, Digital Design and Computer Architecture. 2e. Elsevier. 2013.

MA205N DISCRETE MATHEMATICAL STRUCTURES (2-1-0) 3

Introduction to Propositional Logic. Well - formed formulas – Tautology, Contingency, Contradiction, Normal forms. Predicates and Quantifiers. Inference rules, Types of Proof techniques, Validity of logical arguments. Graph Representations, Directed and Undirected graphs - Introduction and basic properties. Subgraphs,

Isomorphism. Trees, Spanning Trees. Coloring of Graphs. Equivalence relations, Partial order relations, Linear order relations, Hasse diagrams. Lattices, Special classes of Lattices, Boolean algebra and its properties. Boolean expressions and their canonical forms. Groups, Subgroups, Cyclic groups. Cosets, Lagrange's theorem. Applications in AI and DS.

J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill
Kenneth H. Rosen, Discrete Mathematics and Its Applications, 7th Edition, McGraw Hill, 2012.
Douglas B. West, Introduction to Graph Theory, 2nd Edition, PHI, New Delhi, 2003.
Eric Lehman and Tom Leighton, Mathematics for Computer Science, MIT OpenCourseWare (Free PDF).

MA250N LINEAR SYSTEMS AND INTEGRAL TRANSFORMS (2-1-0) 3

Continuous-time and Discrete-time, Even and Odd, Periodic and Aperiodic functions. Linear Time invariant (LTI) systems and their properties. Impulse response, Convolution. Introduction to Transforms: Motivation, Examples. Periodic-Continuous: Fourier Series (Sine, Cosine). Periodic-Continuous: Complex exponential. Aperiodic-Continuous: Fourier Transform. Properties of Fourier Series and Fourier Transform. Applications to solve differential equations. Periodic-Discrete: Discrete Time Fourier Series (DTFS). Aperiodic-Discrete: Discrete Time Fourier Transform (DTFT). Properties of DTFS and DTFT. Discrete Fourier Transform (DFT). Sampling Theorem, Laplace and Z-transform as a special case of Fourier Transform.

E. Oran Brigham, The Fast Fourier Transform and its Applications, Prentice Hall
A. V. Oppenheim, A. S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice Hall Inc., 1997.
Larry C Andrews, Bhimsen Shivamoggi, Integral Transforms for Engineers, SPIE Optical Engineering Press
PP Vaidyanathan, Signals, Systems, and Signal Processing. Cambridge University Press.

MA251N DESIGN AND ANALYSIS OF ALGORITHMS (2-0-2) 3

Introduction to Design and analysis of algorithms, Growth of Functions (Asymptotic notations) Big-O notation. Recurrences, Analyzing recurrences: (i) with trees; (ii) by induction. Recursion tree method, Analyzing recurrences with the master method. Worst case analysis of merge sort, quick sort. Design and analysis of Divide and Conquer Algorithms. Elements of Dynamic Programming, Longest Common Subsequence. Greedy Algorithms, Elements of Greedy Strategy. Knapsack Problem, Huffman Codes. Disjoint Set Operations, Linked list Representation. Minimum Spanning Trees, Kruskal algorithm, Prim's Algorithm. Bellman Ford Algorithm, Dijkstra's Algorithm. Fast Fourier Transform and its application. String matching, Rabin-Karp Algorithm. P, NP, reductions, NP-completeness.

Cormen, Leiserson, Rivest, and Stein, Introduction to Algorithms, MIT Press, 3rd Edition, 2009.
Dasgupta, Papadimitrou and Vazirani, Algorithms, McGraw-Hill Education, 2006.
Horowitz, Sahni, and Rajasekaran, Computer Algorithms, Silicon Press, 2007.
Kleinberg and Tardos, Algorithm Design, Pearson, 2005.

MA252N STATISTICAL INFERENCE (2-1-0) 3

Introduce the concept of sampling, sampling distributions with examples like sampling distribution of the mean, proportion, etc. Discuss the importance of Central Limit Theorem and using Normal distribution approximation to sampling distributions. Sampling distributions of the sample mean and sample proportions and the concept of standard error. Introduce the concept of Estimation - Point estimation and important properties of estimators: consistency, sufficiency, unbiasedness, minimum variance unbiased estimation. Discuss the methods of obtaining point estimators, viz., Method of moments, Maximum likelihood estimation (MLEs) with examples. Introduce Interval estimation and concept of confidence interval for population mean (with known variance) and proportions. Confidence intervals for mean, population variance for two population and difference of means of two population. Introduce the concept of testing of hypothesis, Null and alternative hypotheses, Type I and Type II errors, level of significance and p-value. Large Sample Tests: Introduce z-test

and apply the same for single mean, difference of means and Proportions. Small Sample Tests: Introduce Students t-distribution and apply one-sample t-test, two-sample t- test and paired t-tests. Chi-square goodness of fit test with examples. Test for the equality of variances and ANOVA. Introduce Non-parametric Tests like Sign test, Wilcoxon signed-rank test and spearman's rank correlation, Kolmogorov–Smirnov tests. Applications of these tests to various problems in science and engineering.

Sheldon M. Ros, Introduction to Probability and Statistics for Engineers and Scientists, 5th Ed. Academic Press
Hogg, Robert V., Joseph W. McKean, and Allen T. Craig. Introduction to mathematical statistics. Pearson Education India, 2013.
V.K. Rohatgi and A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, John Wiley & Sons, 3rd Edition, 2015
Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John wiley & sons, 2019.
Wasserman, L., All of statistics: a concise course in statistical inference, Volume 26, New York Springer, 2004. Springer Science & Business Media, 2003.

MA253N MACHINE LEARNING (2-0-2) 3

Introduction to machine learning, motivations, applications, learning paradigms and strategies. Data representation, feature scaling, bias–variance trade-off. Dimensionality reduction: PCA and Fisher's Linear Discriminant Analysis. Probabilistic learning: Bayesian classifier, linear and quadratic discriminant analysis. Optimization methods: gradient descent, stochastic and adaptive gradient techniques. Feature extraction and feature selection methods. Linear models: linear regression and logistic regression. Tree-based models: decision tree classifiers. Support vector machines, margin maximization, kernel tricks. Ensemble learning: bagging, boosting, random forests. Instance-based learning: k-NN and distance-based methods. Cluster analysis: partition and density-based methods. Hierarchical clustering and comparison of clustering approaches. Reinforcement learning fundamentals, recent advances and research directions in ML.

Mitchell, T. M., Machine Learning, McGraw-Hill.
Müller, A. C., and Guido, S., (2016), Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Reilly Media.
Alpaydin, E., Introduction to Machine Learning, 4th Edition, MIT Press.
Shalev-Shwartz, S., and Ben-David, S., Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.
Deisenroth, M. P., Faisal, A. A., and Ong, C. S., (2020), Mathematics for Machine Learning, Cambridge University Press.
Bishop, C. M., (2006), Pattern Recognition and Machine Learning, Springer.

MA254N FOUNDATIONS OF DATA SCIENCE (2-1-0) 3

Relationship between SVD and Eigen Decomposition, Extremal Properties of Eigenvalues. Frobenius norm, Spectral norm, Distance between subspaces. Bounds on Tail Probability, Chernoff Bounds. High-Dimensional Space, Volumes and Surface areas of balls in R^n. Generating Points Uniformly at Random from a Ball. Multi-dimensional Spherical Gaussian, Gaussian annulus theorem. Random projections, Johnson-Lindenstrauss lemma. Separation of Gaussians. Fitting of Spherical Gaussians to a set of data points in R^n. Singular Value Decomposition (SVD) and Best-Fit Subspaces. Best Rank-k Approximations, Power method for SVD. Applications of SVD to Discrete Optimization problem, PCA, Clustering a Mixture of Spherical Gaussian. Random Walks and Markov Chains, Random walks on undirected graphs. Polya's recurrence theorem, Random walks in Euclidean Space.

Avrim Blum, John Hopcroft, and Ravindran Kannan, "Foundations of Data Science", Cambridge University Press (2020)

Roman Vershynin, "High-Dimensional Probability: An Introduction with Applications in Data Science", Cambridge University Press, (2018).

MA255N DATA ANALYTICS AND VISUALIZATION (2-0-2) 3

Statistical foundations: Measure of central tendency, Correlation and covariance, Moments. Univariate & Bivariate Exploratory Data Analysis (EDA). Python visualization tool-Matplotlib: Histogram, scatter plot, box plot. Multivariate statistics and EDA: correlation analysis, imputation, normalization, outlier removal. Correlation heatmaps, Pair plots with examples. Advanced python visualization tools-Seaborn, Plotly with examples. Estimation: Fundamentals (Maximum Likelihood and Bayesian Estimation). Parameter estimation of Gaussian and other standard distributions. Hypothesis testing: Fundamentals. Chi-square test, t-test, ANOVA with examples. Dimensionality reduction: PCA, LDA, Auto-encoder. Linear regression and multiple regression. Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-Score, ROC Curve and AUC. Time-Series data analytics and plots.

Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", 2nd Edition, O'Reilly Media.
David Spiegelhalter, "The Art of Statistics: Learning from Data", Pelican Books

MA300N SYSTEMS AND DATABASES (2-0-2) 3

Purpose of Database Systems, Database System Applications, Differences between File System and Database System. Database system environment, 3 level architecture, types of Database Systems, Different database system models. Data base design using ER diagrams, Entities, Attributes and Entity sets. Relationships and Relationship sets, ER Design Issues. Converting ER diagrams to Database Schema, Keys. Introduction to the Relational Model, Relational Algebra, Complete set of operators. Additional operators, Aggregate functions. Normalization: Introduction, functional dependencies, First, Second, and Third normal forms. Dependency preservation, Boyce-Codd Normal Form (BCNF), Loss-less join decomposition. Overview of the SQL Query Language, Basic Structure of SQL Queries, CRUD operations. Set Operations, JOIN operations. Aggregate Functions, Nested sub queries. Embedded SQL using python. Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control, database recovery management.

Database System Concepts, Silberschatz, Korth, Sudarshan, Mc-graw hill; 7th edition
Fundamentals of Database Systems, Ramez Elmasri, Sham Navathe, Addison-Wesley; 6th edition
Database Systems: Design, Implementation, and Management by Peter Rob and Carlos Coronel, Cengage Learning; 7th edition
Database Systems: A Practical Approach to Design, Implementation, and Management, Thomas Connolly & Carolyn Begg, Addison-Wesley; 8th Edition

MA301N ARTIFICIAL INTELLIGENCE (2-0-2) 3

Introduction to AI, Rational Agents, searching for solutions - Uninformed search strategies: BFS, DFS, Uniform cost search. Deepening depth-first search, Bidirectional search, Informed search: Greedy best-first search, A* search, Memory-bounded heuristic search-Recursive best-first search (RBFS SMA*. Local and evolutionary searches. Hill-climbing search, Simulated annealing, Local beam search. Genetic Algorithms. Adversarial Search: Optimal Decision in Games, The minimax algorithm, Alpha-Beta pruning, Expectimax search Knowledge and Reasoning: Logic, Propositional Logic-syntax, Reasoning Patterns in propositional logic-Model checking, Theorem proving, Resolution, forward chaining. First order logic: syntax, semantics, Inference in First order logic Unification and lifting, backward chaining, Resolution in first order logic. Uncertain knowledge and reasoning Conditional independence representation, exact Inference through variable elimination, Fuzzy set theory for uncertainty.

Russel, S., and Norvig, P., (2015), Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall

Kevin Knight, Elaine Rich and Shivshankar B. Nair, Artificial Intelligence, McGraw Hill, 2017, 3rd Edition.
Nils J Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann Publications, 2000.
Frankish K, Ramsey WM, eds. The Cambridge Handbook of Artificial Intelligence. Cambridge University Press; 2014

MA302N TIME SERIES ANALYSIS (2-1-0) 3

Correlation; Regression methods. Linear, Multilinear regression, Polynomial Regression. Time series analysis: Fundamental components of time series. Definitions, characteristic movements. Measurement of trend, secular trend.

Measurement of seasonal movements. Measurement of cyclical movements and random components. Estimation/elimination of trend and seasonality. Mathematical formulation of time series. Autocovariance and Autocorrelation functions of stationary time series and its properties. Linear stationary processes and their time-domain properties. Formulation of AR, MA, ARMA models. Analysis of AR, MA, ARMA models. Analysis of Seasonal, non-seasonal and Mixed Models.

C. Chatfield, The Analysis of Time Series: An Introduction, Chapman and Hall, 1984.
G. E. P. Box and G. M. Jenkins, Time Series Analysis Forecasting and Control, Holden-Day, 1976.
Montgomery, Douglas C., Cheryl L. Jennings, and Murat Kulahci. Introduction to time series analysis and forecasting. John Wiley & Sons, 2015.
P.J. Brockwell and R.A. Davis, Introduction to Time Series and Forecasting, 2nd Edition, Springer, 2002.
Shumway, R. H., Stoffer, D. S., & Stoffer, D. S. (2000). Time series analysis and its applications (Vol. 3, p. 4). New York: springer.

MA303N SCIENTIFIC COMPUTING (2-1-0) 3

Approximations in scientific computation, floating-point arithmetic. Sensitivity and conditioning of problems, conditioning of linear systems. Gaussian elimination, partial pivoting, and stability considerations. Special linear systems, Jacobi method. Gauss–Seidel method, Successive over relaxation method. Least squares problems, QR factorization, and its applications. Computation of QR factorization using Householder transformations, Givens rotations. Eigenvalue problems, power iteration, and its variants. QR iteration, QR iteration with shifts. Lagrange and Newton interpolation. Error analysis in interpolation, cubic spline interpolation. Newton–Cotes quadrature, composite quadrature rules. Gaussian quadrature, Numerical differentiation, Taylor series methods. Euler's method, Runge–Kutta methods.

Richard L. Burden, Douglas J. Faires and M. A. Burden. Numerical Analysis, 10th ed. Cengage Learning, 2015.
David R. Kincaid and Elliott W. Cheney. Numerical analysis: mathematics of scientific computing. Vol. 2. American Mathematical Soc., 2009.
Michael T Heath. Scientific computing: An introductory survey, revised second edition. Society for Industrial and Applied Mathematics, 2018.
D. S. Watkins, Fundamentals of Matrix Computation, 2nd Ed., Wiley, 2002

MA304N DEEP LEARNING (2-0-2) 3

What is Deep Learning? AI, Machine Learning, and Deep Learning, Historical developments in neural networks, Applications of deep learning. Scalars, vectors, matrices, and tensors, Matrix operations and properties, Eigenvalues and eigenvectors, Norms and matrix decompositions. Random variables and probability distributions, Expectation, variance, covariance, Common distributions (Bernoulli, Gaussian), Entropy, cross-entropy, KL divergence. Numerical stability and precision, Gradient-based optimization overview,Conditioning and ill-conditioning, Automatic differentiation. Learning paradigms: supervised, unsupervised, Generalization and overfitting, Bias–variance trade-off, Cross-validation and regularization. Perceptron and multilayer perceptrons, Activation functions, Universal approximation theorem, Output layers

and loss functions. Gradient descent variants, Backpropagation algorithm, Weight initialization, Challenges: vanishing/exploding gradients. Weight Decay, L1 and L2 regularization, Dropout, Early stopping, Data augmentation. Stochastic gradient descent, Momentum, RMSProp, Adam, Learning rate schedules, Second-order methods (overview). Convolution operation, Pooling and padding, CNN architectures, Applications in vision. Recurrent neural networks (RNNs), Backpropagation through time, LSTM and GRU, Applications in language and time series. Hyperparameter tuning, Model selection and evaluation, Deployment considerations, Ethical and societal aspects, Popular deep learning architectures, Generative models: AEs, VAEs, GAN, Networks. Attention models: Transformers and Vision Transformers. Diffusion models: forward encoder, reverse encoder, score matching.

Goodfellow, I., Bengio, Y., Courville, A. Deep learning (Vol. 1). Cambridge: MIT press.
Aur´elien G´eron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems," Second Edition, O'Reilly Media,2019.
Francois Chollet "Deep Learning with Python," First Edition, Manning Publication 2017.
Sudharsan Ravichandran "Hands-On Deep Learning Algorithms with Python," First Edition, Packt Publishing, 2019

MA350N BIOINFORMATICS (2-0-2) 3

Molecular Biology: Gene structure, DNA, RNA, Central Dogma, Genetic code, Degeneracy, Homology, Similarity, and Identity. Data generation-Generation of large-scale molecular biology data. Sequence Alignments and Visualization: Introduction to Sequences, Alignments, and Dynamic Programming. Local alignment and Global alignment - Pairwise alignment (BLAST and FASTA Algorithm). Multiple sequence alignment (ClustalW algorithm).

Biological Databases: Nucleic acid databases (NCBI, DDBJ, and EMBL), Protein databases. Specialized Genome databases: (SGD, TIGR, and ACeDB), Structure databases (CATH, SCOP, and PDBsum). Searching the databases- BLAST, FASTA, MSA, PSI-BLAST. Visualization of biological data: sequence viewers, 3D structure viewers, Methods for phylogenetic analysis: Phylogenetic trees. Algorithms for Phylogenetic tree construction-Distance matrix methods, Character-based methods. Structural bioinformatics: Introduction to Protein Structure: Proteins, Structure, and Functions of Proteins. Levels of protein structure, Topologies, Secondary structure prediction algorithms.

Algorithms for protein structure prediction and other protein-related tasks. HMM for biological sequences, Profile HMM.

Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Pearson Education India.
Essential Bioinformatics, Laura E. Raymer and Jin Xiong Crane, CRC Press.
Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press.
An Introduction to Bioinformatics Algorithms, Neil C. Jones and Pavel A. Pevzner, MIT Press.
Bioinformatics and Functional Genomics, Jonathan Pevsner, Wiley.

MA351N COMPUTER NETWORKS (2-1-0) 3

Introduction to Computer Networks, Internet structure, network applications and services, protocols. Network edge: applications, processes, sockets, transport service models, overview of all layers. Application layer protocols, security basics. Transport layer: services, multiplexing, UDP, TCP principles. Reliable data transfer, flow control, congestion control fundamentals. IP addressing, subnetting, supernetting, NAT, ARP, ICMP. IPv6 features, fragmentation, reassembly, internetworking concepts. Network Layer Design issues, Routing algorithms, congestion causes, open-loop and closed-loop controls. Link layer services, error detection, correction, sliding window protocols. Multiple access protocols, channel allocation, IEEE 802 LAN standards. Bridges, switches, LANs, MANs, protocol specification and verification. Physical layer concepts, transmission media, wireless communication. Telephone system, Session and presentation layers. Cryptography and Network security basics.

James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Eighth Edition
Tanenbaum A. S, "Computer Networks", PHI 4th Edition
William Stallings, "Data and Computer Communications", PHI 6th Edition.
Douglas Comer, "Computer Networks and Internets", Addison Wesley 2nd Edition.
Behrouz A Forouzan : "Data Communication and Networking", 4th Edition.

MA352N COMPUTER VISION (2-1-0) 3

Digital Image Formation and low-level processing: Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, and Projective. Basics of Image Processing: Image Enhancement, Restoration, Histogram Processing, Fourier Transform, Convolution and Filtering. Depth estimation and Multi-camera views: Perspective, Camera and Epipolar Geometry, Homography, Rectification, DLT, Stereo camera geometry and epipolar constraints, Auto-calibration. Model Fitting: RANSAC, 3-D reconstruction frameworks. Stereo Vision: Essential and fundamental matrix, image rectification, local methods for stereo matching: correlation and multi-scale approaches. Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram.

SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT, Scale invariant feature matching. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Texture segmentation and object detection. Motion Analysis: Background Subtraction and Modelling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Shape Analysis: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges. ML in Computer Vision: Image Recognition; Tracking. Pre-trained CNN models in computer Vision. Applications of machine learning in computer vision Models. Action/Activity Recognition, Introduction to Attention Models in Vision, Vision and Language, Visual QA, Visual Dialog.

Forsyth, D. A. and Ponce, J.," Computer Vision: A Modern Approach", Prentice Hall, 2nd Ed, 2011.
Szeliki, R.," Computer Vision: Algorithms and Applications", Springer, 2011.
Gonzalez, R. C. and Woods, R. E.," Digital Image Processing", Prentice Hall, 3 rd Ed., 2009.
François Chollet "Deep Learning with Python," First Edition, Manning Publication 2017.

MA353N DATA MINING AND WAREHOUSING (3-0-0) 3

Motivation and significance of data mining, data mining tasks, taxonomy, major issues, KDD process. Data preprocessing: data cleaning, integration, transformation, reduction, discretization. Introduction to data warehousing, OLTP vs OLAP, data warehouse components. Data warehouse architecture, data staging, data marts, metadata. Multidimensional data Modelling: star schema, snowflake schema, etc. OLAP operations: slice, dice, roll-up, drill-down, pivot; OLAP server types. Data cube computation, aggregation techniques, design issues and applications. Frequent pattern mining concepts, association rules, interestingness measures, Apriori algorithm. FP-Growth algorithm, Multilevel and multidimensional associations, constraint-based association mining. Classification basics: decision trees, Bayesian classification, rule-based classification. Lazy learners (k-NN), support vector machines, prediction using regression. Ensemble methods, model evaluation, accuracy and error metrics. Cluster analysis, partition methods, hierarchical method, and density method. Outlier detection; mining methods for unstructured and semi-structured data.

Han, J., Kamber, M., and Pei, J., Data Mining: Concepts and Techniques, Morgan Kaufmann.
Fayyad, U. M., Piatetsky-Shapiro, G., and Smyth, P., Advances in Knowledge Discovery and Data Mining, MIT Press.
Tan, P.-N., Steinbach, M., and Kumar, V., Introduction to Data Mining, Pearson Education.
Kimball, R., and Ross, M., The Data Warehouse Toolkit: The Complete Guide to Dimensional Modelling, Wiley.

MA354N NATURAL LANGUAGE PROCESSING (2-0-2) 3

Introduction to NLP, Applications, Challenges, and Linguistic Foundations. Regular Expressions, Text Normalization, Tokenization Techniques. Morphology, Lemmatization, Stemming, Part-of-Speech Tagging. Noun Phrase Chunking and Named Entity Recognition, Coreference Resolution. Parsing Techniques. Information Extraction, Sentiment Analysis and Text Classification. Naive Bayes for Text Classification, Log-linear Models and Conditional Random Fields. N-gram Language Models, Language Models: Classical and Neural. Word2Vec and Vector Representations, Other embedding techniques. Document Clustering and Document Summarization. Introduction to RNN-based Neural Models, RNNs and LSTMs. Transformers and Attention Mechanisms, Pre-trained Language Models. Masked Language Models and Multilingual Language Models, Parameter Efficient Fine-Tuning. In-Context Learning and Prompt Engineering. Question Answering Systems and Information Retrieval, Dialogue Systems and Chatbots.

Machine Translation and Multilingual NLP.

Dan Jurafsky and James Martin, Speech and Language Processing, 3rd Edition.
Yoav Goldberg, Neural Network Methods for Natural Language Processing, Morgan and Claypool (2017).
Introduction to Natural Language Processing, Jacob Eisenstein, MIT Press, 2019
Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press

MA355N OPERATING SYSTEM (2-1-0) 3

Operating system functionalities, services, system calls, and types of operating systems. Process concept, process states, process control block, process creation. Threads, multithreading models, process management, fork system call. Inter-process communication: shared memory, message queues, pipes. CPU scheduling concepts, scheduling criteria, FCFS, SJF, Round Robin algorithms. Process synchronization, critical section problem, semaphores, Peterson's solution. Deadlocks: characterization, prevention, avoidance, and recovery techniques. Deadlock avoidance algorithms, resource allocation graph, Banker's algorithm. Memory management concepts, paging, segmentation, swapping. Virtual memory, demand paging, page replacement concepts. Page replacement algorithms: FIFO, Optimal, LRU. Memory fragmentation, internal and external fragmentation, compaction techniques. File system management, disk scheduling algorithms, I/O management. Protection and security, system design concepts, Docker and microservices.

Silberschatz, A., Galvin, P. B., and Gagne, G., (2018), Operating System Concepts, 10th Edition, Wiley.
Stallings, W., (2018), Operating Systems: Internals and Design Principles, 9th Edition, Pearson Education.
Tanenbaum, A. S., and Bos, H., (2015), Modern Operating Systems, 4th Edition, Pearson Education.
Bach, M. J., (1986), The Design of the UNIX Operating System, Prentice Hall.
Bovet, D. P., and Cesati, M., (2005), Understanding the Linux Kernel, 3rd Edition, O'Reilly Media.

MA356N SOFT COMPUTING (2-1-0) 3

Need for Soft Computing, Characteristics of Soft Computing, Soft Computing vs Hard Computing, Applications. Overview Fuzzy Sets, Membership Functions, Operations on Fuzzy Sets. Fuzzy Relations, Propositions, and Inference, Defuzzification Techniques. Fuzzy Rule-Based Systems and Fuzzy Controllers, Applications of Fuzzy Logic. Concept of Evolutionary Algorithms, Genetic Algorithm Framework, Operators: Encoding, Selection. Crossover, Mutation, Solving Single-objective Optimization Problems, Basics of Multi-Objective Evolutionary Algorithms. Overview of Artificial Neuron Model and Activation Functions. Approximate Reasoning and Learning, Neuro-Fuzzy Systems. Applications of Neural Networks in Soft Computing, Recent Trends and Extensions of Artificial Neural Networks. Genetic Algorithms combined with Fuzzy Systems, Genetic Algorithms combined with Neural Networks. Basics of Swarm Optimization Techniques: Ant Colony Optimization. Particle Swarm Optimization, Applications in Engineering and AI. Real-world Case Studies: Soft Computing for Control Systems. Data Mining, Robotics, Smart Systems; Discussion on Recent Trends.

S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing", Wiley India, 3rd Edition, 2018.
Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, 4th Edition, 2020
Simon Haykin, "Neural Networks and Learning Machines", Pearson, 3rd Edition, 2009.
David E. Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison-Wesley, 1989.

MA357N THEORY OF COMPUTATION (3-0-0) 3

Finite state automata, deterministic and nondeterministic FSA, ε-moves. Regular expressions, equivalence of regular expressions and finite automata. Pumping lemma for regular languages, closure properties, decidability. Myhill–Nerode theorem, minimization of finite automata, automata with output. Grammars and production systems, Chomskian hierarchy. Right linear grammar, equivalence with finite automata. Context-free grammars, derivations, parse trees, ambiguity. Normal forms, uvwxy theorem, Parikh mapping, self-embedding property. Pushdown automata, acceptance by empty store and final state. Equivalence of PDA and CFG, closure properties, deterministic PDA. Turing machines, construction techniques, variants, universal Turing machine. Recursive and recursively enumerable sets, computable functions, Godel numbering. Decidability, PCP, Rice's theorem, decidability of language problems.

Time and space complexity, P and NP, NP-completeness, Cook's theorem.

Hopcroft, J. E., Motwani, R., and Ullman, J. D., Introduction to Automata Theory, Languages, and Computation, 3rd Edition, Pearson Education.
Sipser, M., Introduction to the Theory of Computation, 3rd Edition, Cengage Learning.
Kozen, D. C., Automata and Computability, Springer.
Lewis, H. R., and Papadimitriou, C. H., Elements of the Theory of Computation, 2nd Edition, Prentice Hall.
Garey, M. R., and Johnson, D. S., Computers and Intractability: A Guide to the Theory of NP-Completeness, W. H. Freeman.

MA398N/ MA448N/ MA498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

MA399N MAJOR PROJECT - I (0-0-18) 9

The students jointly or individually will be assigned an experimental or a theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VI, VII & VIII semester. The students should complete the preliminary literature survey and a part of the work in the VII semester. Their work will be reviewed and evaluated.

MA449N MAJOR PROJECT - II (0-0-18) 9

MA499N MAJOR PROJECT - III (0-0-18) 9

MA400N COMPUTATIONAL NUMBER THEORY AND CRYPTOGRAPHY (2-1-0) 3

Computational Complexity: Input Size, Complexity Classes etc. GCD Computation: Euclid's Algorithm, Extended Euclid's Algorithm. Modular Arithmetic: Groups, Solving Modular Linear Equations. Chinese Remainder Theorem. Modular Exponentiation, Discrete Logarithm Problem. Computation of Generators of

Primes, Quadratic Residues. Key Exchange: Diffie Hellman, ElGamal. Public Key Cryptosystem: RSA, Different Attacks & Remedies. Primality Testing: Pseudoprimality Testing, Randomized vs. & Deterministic Primality Test. Elliptic Curve Cryptosystem: Theory of Elliptic Curves, Elliptic Curve Encryption & Decryption. Algorithms, Security of Elliptic Curves Cryptography. Digital Signatures: Authentication Protocols, Digital Signature Standards (DSS). RSA & Rabin Signature schemes. ECDSA (Elliptic Curve Digital Signature Algorithm). Factorization: Quadratic-Sieve Factoring Algorithm, Pollard-Rho Method. Continued fraction method for factorization.

N. Koblitz, A Course in Number Theory and Cryptography, Springer 2006.
V. Shoup, A Computational Introduction to Number Theory and Algebra, Cambridge University Press 2008.
Alfred Menezes, Paul van Oorschot, and Scott Vanstone, Handbook of Applied Cryptography, CRC Press 1996.
William Stallings, Cryptography and Network Security, Prentice-Hall, Inc. 2005.

MA401N GRAPH MODELS AND ALGORITHMS (2-1-0) 3

Graph representations: adjacency list/matrix, edge list, Graph Traversal Algorithms: Breadth-First Search (BFS), Depth-First Search (DFS). Shortest Path Algorithms: Dijkstra's Algorithm, Bellman-Ford Algorithm, Floyd-Warshall Algorithm. Applications in Connectivity, Topological Sort, Cycle Detection, Routing and Navigation. Minimum Spanning Trees: Kruskal's Algorithm, Prim's Algorithm. Union-Find Data Structures, Network Flow Algorithms: Ford-Fulkerson Method, Max-Flow Min-Cut Theorem. Edmonds-Karp Algorithm, Applications in Matching. Graph Models: Random Graphs (Erdős–Rényi model), Small-World Networks (Watts–Strogatz), Scale-Free Networks (Barabási–Albert). Real-world graph properties (diameter, clustering, degree distribution). Graph Coloring and Partitioning: Greedy coloring, Chromatic number. Graph partitioning: Kernighan-Lin, Spectral Partitioning, Applications in scheduling and VLSI design, Centrality and Influence in Networks: Degree, Closeness, Betweenness, Eigenvector Centrality, PageRank and HITS Algorithms. Matching and Covering Problems: Bipartite Matching (Hungarian Algorithm), Maximum Matching (Hopcroft-Karp), Vertex Cover and Independent Set. Spectral Graph Theory: Graph Laplacian and Eigenvalues, Applications in Clustering, Dimensionality Reduction. Graph Algorithms in Practice: Graph databases (Neo4j, Gremlin), Graph processing systems (Apache Giraph, GraphX). Case studies: social networks, knowledge graphs, web graphs.

Douglas B. West, Introduction to Graph Theory, 2nd Edition, PHI Learning, New Delhi, 2003.
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, PHI Learning, 2001.
Dieter Jungnickel, Graphs, Networks and Algorithms, 3rd Edition, Springer, 2008.
Eric Lehman and Tom Leighton, Mathematics for Computer Science, MIT OpenCourseWare (Free PDF).

MA402N NETWORK SECURITY (2-0-2) 3

Basics of cryptography, private-key cryptography. Public-key cryptography. Hash functions, digital signatures and authentication protocols. Key Management and Distribution: Symmetric Key Distribution. Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure. Remote User-Authentication Principles, Remote User-Authentication Using Symmetric Encryption. Kerberos Systems, Remote User Authentication Using Asymmetric Encryption. Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access. Control, IP Security, Internet Key Exchange (IKE). Transport Layer Security: TLS, Secure Socket Layer, Secure Electronic Transaction. Web Security Considerations, HTTPS standard, Secure Shell (SSH) application. Electronic Mail Security: Pretty Good Privacy, S/MIME, DNSSEC. Wireless Network Security: WAP, WEP, WPA, Mobile Device Security. Firewall Characteristics, Types of Firewalls, Firewall Location and Configurations. Intrusion Detection, Types of Attack, Password Management.

William Stallings, Cryptography and Network Security: Principles and Practice, Pearson, 2017
Atul Kahate, Cryptography and Network Security, Tata McGraw Hill, 2017

M. Speciner, R. Perlman, C. Kaufman, Network Security: Private Communications in a Public World, Prentice Hall, 2002
William Stallings, Network security Essentials: Applications and standards, Prentice Hall,2000.
Behrouz A Forouzan, Cryptography and Network Security; McGraw Hill, 2007.

MA403N PATTERN RECOGNITION (2-0-2) 3

Introduction to statistical approach for pattern recognition. Bayes classifier, Naive Bayes. Examples for designing Bayes classifier. Maximum likelihood estimation: Theory and formulation. Maximum likelihood parameters estimation of Gaussian, Bernoulli, Gamma and other distributions. Bayesian estimation: Theory and formulation. Bayesian estimation of parameters of Gaussian, Bernoulli, Gamma and other distributions. Density estimation with Gaussian mixture models. Expectation-Maximization algorithm. Non-parametric density estimation methods. Linear discriminant functions. Perceptron Learning. Model Assessment and Selection: Bias- variance trade off, Minimum Description Length, AIC, BIC. Stochastic Methods: Boltzmann learning and graphical models.

Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition, Wiley, 2001.
Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

MA404N MONTE CARLO SIMULATION (1-1-2) 3

Principles of Monte Carlo. Generation of random numbers from a uniform distribution. Linear congruential generators and its variations. Generation of discrete random variables. Generation of continuous random variables. Inverse transform and acceptance-rejection method. Simulation of univariate normally distributed random variables. Box-Muller method. Marsaglia method. Generation of multivariate normally distributed random variables. Cholesky factorization. Variance reduction techniques.

P. Glasserman, Monte Carlo Methods in Financial Engineering, Springer, 2004.
R. U. Seydel, Tools for Computational Finance, 5th Ed., Springer, 2012.
Brandimarte, Paolo. Handbook in Monte Carlo simulation: applications in financial engineering, risk management, and economics. John Wiley & Sons, 2014.

MA405N MULTIVARIATE STATISTICAL ANALYSIS (2-1-0) 3

Review of multivariate normal distribution and its properties. Distributions of linear and quadratic forms. Tests for partial and multiple correlation coefficients. Tests for regression coefficients and their associated confidence regions. Confidence regions for partial and multiple correlation coefficients. Confidence regions for the regression coefficient. Wishart distribution. Inference on covariance matrices. Discriminant analysis. Principal component analysis and its applications. Factor analysis and clustering. Dimension reduction techniques: Principal component analysis. Generalized canonical variable analysis. Applications.

T. W. Anderson (1984), An Introduction to Multivariate Statistical Analysis. 2nd Ed. John Wiley.
R. A. Johnson and D. W. Wichern (2013), Applied Multivariate Statistical Analysis. 6th Ed. Pearson.
M. S. Srivastava and C. G. Khatri (1979), An Introduction to Multivariate Statistics, Elsevier North Holland, Inc., New York
C. R. Rao (2002), Linear Statistical Inference and its Applications. 2nd Ed. Wiley.

MA406N TOPOLOGICAL DATA ANALYSIS (2-1-0) 3

Data: Types. Data Matrices, Dissimilarity Matrices and Metrics. Topology: Definition, Examples, Basic Results. Continuous Maps and Homeomorphisms. Metric spaces, Examples, Basic results. Homotopy and Homotopy Equivalences. Constructing Topological Spaces and Maps using Quotients and Products. Simplicial Complexes, Betti Numbers. Chain Complexes, chain maps and chain homotopies. Homology groups, singular homology and Functoriality. Clustering, Complexes for Point Cloud Data. The Mapper algorithm, Persistence.

Algebra of persistence vector spaces. Barcode spaces and Metrics on Barcode Spaces. Applications: Viral Evolution, Vectorization Methods and Machine Learning etc.

Gunnar Carlsson, Mikael Vejdemo-Johansson, Topological Data Analysis with Applications, Cambridge Univ. Press, 2022.
Tamal K. Dey and Yusu Wang, Computational Topology for Data Analysis, Cambridge Univ. Press, 2022.
Edelsbrunner, Herbert, and John Harer. Computational Topology: An Introduction, Amer. Math. Soc., 2010.
Hatcher, Allen. Algebraic Topology, Cambridge Univ. Press, 2001.

MA407N PHYSICS-INFORMED NEURAL NETWORKS (PINNS) (2-1-0) 3

Motivation for PINNs and comparison of physics-based, numerical, and data-driven approaches. Fundamentals of machine learning and neural networks as function approximators. Deep learning basics, activation functions, and conceptual understanding of backpropagation. Review of ordinary and partial differential equations with boundary and initial conditions. Universal Approximation Theorem and neural network representation of differential equation solutions. Residual minimization approach and comparison between collocation methods and PINNs. Automatic differentiation, computational graphs, and gradient evaluation in neural networks. PINN framework and construction of physics-based and data-based loss functions. Training PINNs for ordinary differential equations using simple harmonic oscillator examples. PINN formulation for one- and two-dimensional Poisson equations. Enforcing boundary and initial conditions using hard and soft constraint techniques. Selection of collocation points and basic optimization challenges in PINN training. Comparison of PINNs with finite difference and finite element methods. Applications of these tests to various problems in science and engineering.

Karniadakis, G. E., Kevrekidis, I. G., Lu, L., Perdikaris, P., Wang, S., & Yang, L. Physics-Informed Machine Learning, Springer, 2021.
Goodfellow, I., Bengio, Y., & Courville, A, Deep Learning, MIT Press, 2016
Kreyszig, E., Advanced Engineering Mathematics, Wiley.
Smith, R. C., Uncertainty Quantification: Theory, Implementation, and Applications SIAM, 2014.

MA450N DIGITAL IMAGE PROCESSING AND CODING (2-1-0) 3

Basic steps of Image processing system, sampling and quantization of an Image. Image Enhancement, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters. Image Transforms, Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms. Frequency Domain methods, Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering. Image Segmentation, Segmentation concepts, point, line and Edge detection, thresholding, region based segmentation. Image restoration: Noise models, Image Denoising, Image deblurring and enhancement. Morphological Image Processing. Color Image Processing: Color fundamentals, Different Color spaces, Pseudo coloring. Image Compression and coding fundamentals, coding Redundancy, spatial and temporal redundancy. Compression models, Lossy and Lossless models.

Coding Techniques: Huffman coding, Arithmetic coding, LZW coding, run length coding. Bit Plane coding, transform coding, predictive coding, wavelet coding. Lossless Coding: JPEG and JBIG Coding. Processing of images with different representations from medical and satellite domains. Research directions in image processing and coding.

Gonzaleze and Woods," Digital Image Processing ", 3rd edition, Pearson, 2008.
A.K. Jain, Fundamentals of Digital Image Processing, Pearson,2015.
Introduction to Digital Image Processing William K. Pratt, CRC Press, 2013
Chris Solomon, Toby Breckon, Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab, John Wiley & Sons, 2011.

MA451N DIGITAL VIDEO PROCESSING AND CODING (2-1-0) 3

Basic Steps of Video Processing. Analog video, Digital Video, Time varying Image Formation models. 3D motion models, Geometric Image formation, Photometric Image formation. Sampling of video signals, filtering operations. 2-D Motion Estimation, Optical flow, general methodologies. pixel based motion estimation, Block matching algorithm. Mesh based motion Estimation, global Motion Estimation. Region based motion estimation, multi resolution motion estimation. Video coding: Basics of video coding, Content dependent video coding, Two-dimensional shape coding. Texture coding for arbitrarily shaped region, Joint shape and texture coding. Waveform based coding, Block based transform coding. Application of motion estimation in video coding. Video compression standards MPEG-4 Visual and H.264/AVC: Standards for Modern Digital Video. H.265/HEVC, HEVC Coding tools and extensions.

Yao wang, Joem Ostarmann and Ya-Quin Zhang, Video processing and communication ,1st edition, PHI, 2010.
M. Tekalp, Digital video Processing, Prentice Hall International, 2nd Edition, 2015.
IAlan C. Bovik, The Essential Guide to Video Processing, 2nd Edition, Academic Press Inc, 2009
J.W. Woods, Multidimensional Signal, Image and Video Processing and Coding, Academic Press, 2nd edition, 2012

MA452N OPERATIONS RESEARCH (2-1-0) 3

Introduction to Operations Research, Different Types of OR Models, Revision of linear programming problem (LPP), graphical method. Simplex method, Big-M method. Two-Phase method, Revised Simplex Method. Duality theory, Dual Simplex Method. Sensitivity Analysis, Parametric LPP. Integer and mixed integer LPPs: Cutting plane method. Integer and mixed integer LPPs: Branch and bound technique. Transportation problem formulation: Dual problem, North-West Corner. Least Cost Methods, Vogel's Approximation Method. UV-method. Assignment Problems: Formulation and the Hungarian Method. Game Theory: Minimax (Maximin) criterion, Saddle point. Notion of dominance, Graphical Methods for Rectangular Games. LPP approach for Rectangular Games.

Taha, H.A., Operations Research: An Introduction, Pearson Education, India.
Ravindran, A., Phillips, D.T. and Solberg, J.J., Operations Research: Principles and Practice, John Wiley and Sons, NY, Second Edition (Reprint).
Hillier, F.S., Lieberman, G.J., Introduction to Operations Research, Concepts and Cases, 8th Edition, 2010, TMH.
Bazaraa, M.S., Jarvis, J. J. and Sherali, H. D., Linear Programming and Network Flows, John Wiley and Sons, Fourth Edition.

MA453N PROBABILISTIC GRAPHICAL MODELS (2-1-0) 3

Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields). Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph; Conditional Independence (Bayes Ball Theorem and D-separation). Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps). Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field. Exact Inference, Variable Elimination, Elimination Orderings, Relation to Dynamic Programming. Dealing with Evidence, Forward-Backward Algorithm. Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum Product); Approximate Inference Variational Methods (Mean Field, Kikuchi & Bethe Approximation). Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product. Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP);. Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & amp; Blocking), Particle filtering. Parameter Estimation, Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood. Bayesian Estimation, Conditional Likelihood, Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.

Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques, First Edition, MIT Press, 2009
Adnan Darwiche, Modelling and Reasoning with Bayesian Networks, Cambridge University Press, 2009.
Kevin P. Murphy, Machine Learning: a Probabilistic Perspective, MIT Press, 2012.
Jensen, F. V. and Nielsen, T. D. Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
Barber, D. Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition, 2011

MA454N ADVANCED DATA STRUCTURES (2-0-2) 3

Recap of basic data structures. Trees, Search Trees, Balanced Search Trees: Height Balanced, Weight Balanced. B-Trees, B+ Trees. Red-Black Trees, Splay Trees, Skip List. Trees for Set of Intervals: Interval Trees, Segment Trees. Heaps: Leftist Heap, Binomial Heap, Fibonacci Heap. Union-Find and related data structures, Problems in Dynamic Programming. Data structure for strings. Tries and Compressed Tries. Suffix trees and Arrays, Dictionary data structures. K-Dimensional Tree, Advanced Lists, Branch and Bound. X-OR List, Self Organizing list. N-Ary trees, Hash Tables. Graph representations and Greedy Algorithms.

Brass, Peter. Advanced data structures. Vol. 193. Cambridge: Cambridge University Press, 2008.
Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.
Pai, G. A. V. (2023). A Textbook of Data Structures and Algorithms, Volume 3: Mastering Advanced Data Structures and Algorithm Design Strategies. Wiley.
La Rocca, M. (2021). Advanced Algorithms and Data Structures. Manning Publications

MA455N HIGH PERFORMANCE COMPUTING (2-1-0) 3

Introduction HPC: Motivation, Applications in science, engineering, and AI, Performance metrics: throughput, latency, speedup, efficiency. HPC Architectures: Shared memory vs distributed memory systems, UMA and NUMA architectures, Cluster architectures and interconnection networks, Overview of modern supercomputers. Fundamentals of Superscalar Processors – I: Instruction-level parallelism, Pipelining concepts, Superscalar execution, Out-of-order execution and register renaming. Fundamentals of Superscalar Processors – II: Branch prediction techniques, Speculative execution, Cache hierarchy and memory consistency, Performance limitations and bottlenecks. Vector Processors and Accelerator Architectures: Vector processing concepts, SIMD and SIMT models, Architectural overview of GPUs, Introduction to accelerators in HPC. Advanced Accelerators: GPGPU architecture details, Intel Xeon Phi architecture, FPGA-based acceleration, Comparison of accelerators for HPC workloads. Programming Models for HPC Cluster: Parallel programming paradigms, Introduction to OpenMP, OpenMP directives, scheduling, and synchronization. MPI Programming: MPI architecture and execution model, Point-to-point communication, Collective communication operations. MPI Programming: Communicators and process topology, Hybrid MPI + OpenMP programming. Programming for Accelerators – I: CUDA programming model, Thread hierarchy and memory model, Writing and optimizing CUDA kernels. Programming for Accelerators – II: OpenCL programming model, Programming considerations for Xeon Phi, Performance optimization techniques. HPC Performance Evaluation and Benchmark: Overview of LINPACK and HPL, Benchmarking methodology. Week 13: Introduction to Deep Learning Frameworks: Overview of deep learning workloads, Introduction to Caffe and TensorFlow, Computational patterns in DNNs. Week 14: HPC Techniques in DNN Frameworks: Parallelism in deep learning: data and model parallelism, GPU acceleration and distributed training, TPUs and their architecture, Case studies of HPC-enabled deep learning systems.

David J. Kuck, High Performance Computing, Oxford Univ Press, 1996
John L. Hennessy, David A Patterson, Computer Architecture - A Quantitative Approach, 5th Edition, Morgan Kaufmann, 2011.

Dennis Abts, John Kim, High Performance Datacenter Networks - Architectures, Algorithms, and Opportunities. Mark Hill/Margaret Martonosi (Eds.). Synthesis Lectures on Computer Architecture, Morgan and Claypool, 2011.
David B. Kirk, Wen -mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series) Elsevier-2014.

MA456N FINANCIAL MATHEMATICS (3-0-0) 3

Basics of financial markets, market efficiency. Stock market anomalies, risk–return tradeoff. Markowitz portfolio model, efficient frontier, minimum variance portfolio. Sharpe ratio, Treynor ratio, Jensen's alpha. Assumptions of Capital Asset Pricing Model (CAPM), Beta estimation and interpretation. Concept of arbitrage, Single-factor and multi-factor APT models. Fama–French three-factor model, Carhart four-factor model. Liquidity-augmented factor models, portfolio Optimization. Definition and purpose of derivatives, forward and futures contracts. Introduction to options, futures pricing and settlement, arbitrage opportunities. Single-period binomial model, Multi-period binomial model. Basics of Stochastic Calculus, Cox–Ross–Rubinstein (CRR) model. Derivation of Black–Scholes formula, Black–Scholes formula for option pricing as a limit of the CRR model. Greeks, derivative strategies.

Goodman and Stampfli, The Mathematics of Finance: Modelling and Hedging, Brooks/Cole, 2001.
S. E. Shreve, Stochastic Calculus for Finance I and II, Springer Verlag, 2005.
Ales Cerny, Mathematical Techniques in Finance: Tools for incomplete Market, Princeton University Press, 2009.

MA457N STOCHASTIC ANALYSIS AND APPLICATIONS (3-0-0) 3

Stochastic processes, basic concepts. Classification of states. Markov chains. Limiting Probabilities. C – K equations, Ergodic chains. Steady state behaviour. Poisson process. Continuous time Markov chains. Birth and Death Processes. The Transition Probability Function. Queuing systems, basic concepts. M|M|1 and M|M|s queues. Reliability models, Concept of hazard, bathtub curve. System reliability for various configurations.

Ross, Sheldon M. Stochastic Processes, 2nd Ed., Wiley, 2008.
Ross, Sheldon M. Introduction to Probability Models. Academic Press, 2014.
J. Medhi, Stochastic Processes, 3rd Ed., New Age International, 2009.
Castañeda, Liliana Blanco, Viswanathan Arunachalam, and Selvamuthu Dharmaraja. Introduction to probability and stochastic processes with applications. John Wiley & Sons, 2012.
U. N. Bhat, G. K. Miller, Elements of Applied Stochastic Processes, Wiley, 2002
K. S. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, 2nd Ed., Wiley, 2001.

MA458N GAME THEORY (3-0-0) 3

Introduction, Definition of Games, Examples. Actions, Strategies, Preferences, Payoffs. Strategic form games and examples, Prisoner's Dilemma, Bach or Stravinsky. Dominant Strategy Equilibrium. Strongly dominant strategies. weakly dominant strategies. Dominant strategy equilibrium examples of Prisoner's Dilemma and Vickrey Auction. Two Player Zero Sum Games (Matrix Games). Max minimization and Min maximization, Saddle points. Nash equilibrium in matrix gamesMinimax theorem. Solution via linear programming & Examples. Bayesian Games, Motivational Examples. Definition and examples of a Bayesian Game. Bayesian Nash Equilibrium and examples.

Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003.
Y. Narahari, Game Theory and Mechanism Design, IISc Press and World Scientific, 2014.
Philip D. Straffin, Jr. Game Theory and Strategy, The Mathematical Association of America, January 1993.
Ken Binmore, Fun and Games: A Text On Game Theory, D. C. Heath & Company, 1992.

Department of Mechanical Engineering (ME)
Bachelor of Technology in Mechanical Engineering

Basic Science Courses (BSC)

CY100N	Engineering Chemistry	(3-0-2)4
MA104N	Ordinary Differential Equations and Transforms	(3-0-0)3
MA106N	Partial Differential Equations and Fourier Transforms	(3-0-0)3
PH100N	Engineering Physics	(3-0-2)4
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

CS101N	Computer Programming (Python)	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
UC101N	Introduction to Engineering	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC)

ME201N	Mechanics of Deformable Bodies	(2-1-0)3
ME202N	Structural and Functional Materials	(2-1-0)3
ME203N	Fluid Mechanics	(2-1-0)3
ME204N	Computer Aided Drawing Practice	(0-0-6)3
ME205N	Mechanics of Solids and Fluids Lab	(0-0-6)3
ME206N	Mechatronic Systems	(3-0-0)3
ME251N	Kinematics and Dynamics of Machinery	(2-1-0)3
ME252N	Engineering Thermodynamics	(2-1-0)3
ME253N	Manufacturing Processes	(2-1-0)3
ME254N	Machining, Training and Applied Engineering Lab	(0-0-6)3
ME255N	Computer Aided Engineering and Dynamics Lab	(0-0-6)3
ME301N	Design of Machine Elements	(2-1-0)3
ME302N	Modern Manufacturing and Metrology	(3-0-0)3
ME303N	Heat Transfer	(2-1-0)3
ME304N	Thermal Engineering Laboratory	(0-0-6)3
ME305N	Metrology, Measurements and Mechatronic Lab	(0-0-6)3

Department Elective Courses (DEC)

ME261N	Computational Methods in Engineering	(3-0-0)3
ME262N	Composite Materials	(3-0-0)3
ME263N	Wind Energy	(3-0-0)3
ME264N	Aerodynamics	(2-1-0)3
ME265N	Materials Selection for Manufacturing	(2-1-0)3
ME266N	Engineering Product Development	(3-0-0)3
ME267N	Control systems	(3-0-0)3
ME268N	Microsystems Technology	(3-0-0)3
ME351N	Finite Element Method	(3-0-0)3
ME352N	Defence Science Technology	(2-1-0)3
ME353N	Introduction to Aircraft Structure	(2-1-0)3
ME354N	Theory of Elasticity	(2-1-0)3
ME355N	Computational Fluid Dynamics	(2-1-0)3
ME356N	Fuel Cell Science and Technology	(2-1-0)3
ME357N	Energy Conversion and Storage	(3-0-0)3
ME358N	Measurement Methods in Thermal Engineering	(2-1-0)3
ME359N	Fundamentals of Additive Manufacturing	(2-1-0)3
ME360N	Micro and Nano Manufacturing	(3-0-0)3
ME361N	Operations Research	(3-0-0)3
ME362N	Artificial Intelligence and Machine Learning for Mechanical Engineers	(3-0-0)3
ME363N	Semiconductor Chip Manufacturing	(3-0-0)3
ME364N	Automation Systems	(3-0-0)3
ME365N	Robotic Manipulators – Modelling to Hardware	(3-0-0)3
ME366N	Applied Mechatronics in Medicine and Rehabilitation	(3-0-0)3
ME401N	Multi-Body Dynamics and Applications	(2-1-0)3
ME402N	Theory of Fatigue and Analysis	(3-0-0)3
ME403N	Experimental Stress Analysis	(2-1-0)3
ME404N	Synthesis of Mechanisms	(2-1-0)3
ME405N	Internal Combustion Engines	(2-1-0)3
ME406N	Hydrogen Generation, Storage and Utilisation	(2-1-0)3
ME407N	Microfluidics	(2-1-0)3
ME408N	Thermal Management of Electronic Devices	(3-0-0)3
ME409N	Sustainable Manufacturing	(3-0-0)3
ME410N	Non-Destructive Evaluation	(3-0-0)3
ME411N	Production Operations Management	(2-1-0)3
ME412N	Post-Processing of Additively Manufactured Parts	(3-0-0)3
ME413N	Modelling and Simulation of Mechatronics Systems	(3-0-0)3
ME414N	Electric Vehicle Technologies	(3-0-0)3
ME415N	Dynamics and Control of Mechanical Systems	(3-0-0)3
ME451N	Vehicle Dynamics	(3-0-0)3
ME452N	Condition Monitoring	(3-0-0)3
ME453N	Injury Biomechanics	(3-0-0)3
ME454N	Mechanical Vibration and Acoustics	(3-0-0)3
ME455N	Refrigeration & Air Conditioning	(2-1-0)3
ME456N	Compressible Flows	(2-1-0)3
ME457N	Gas Turbine and Jet Propulsion	(2-1-0)3
ME458N	Principles of Turbomachinery	(2-1-0)3
ME459N	Engineering Tribology	(3-0-0)3
ME460N	Surface Modification and Characterization	(3-0-0)3
ME461N	AI in Manufacturing	(3-0-0)3

ME462N	Bio Manufacturing	(2-1-0)3

Internship/Major Project Courses (IPC)

ME398N	Internship-I	(0-0-18)9
ME399N	Major Project I	(0-0-18)9
ME448N	Internship-II	(0-0-18)9
ME449N	Major Project II	(0-0-18)9
ME498N	Internship-III	(0-0-18)9
ME499N	Major Project III	(0-0-18)9

Honors Courses

Students seeking an Honors degree shall credit a minimum of 15 additional credits from Postgraduate courses offered by the respective Department, as decided by the DUGC.

Note: For details on PL1XWN/ PL1X9N, PL1YWN/ PL1Y9N, PL2XWN/ PL2X9N, PL2YWN/PL2Y9N, PL3XWN/ PL3X9N refer page …

Suggested Plan of Study for B.Tech. in Mechanical Engineering:

Slot/ Semester	I	II	III	IV	V	VI	VII	VIII
1	PH100N	CY100N	ME201N	ME251N	ME301N	ME398N/ ME399N	ME448N/ ME449N	ME498N/ ME499N
2	MA104N	MA106N	ME202N	ME252N	ME302N	Dept./ Institute Elective-1	Dept./ Institute Elective-4	Dept./ Institute Elective-6
3	UC102N	UC103N	ME203N	ME253N	ME303N	Dept./ Institute Elective-2	Dept./Institute Elective-5	Dept./ Institute Elective-7
4	UC101N	UC100N	ME204N	ME254N	ME304N	Dept./ Institute Elective-3		
5	CS101N	DE100N	ME205N	ME255N	ME305N			
6	PL1XWN / PL1X9N	PL1YWN / PL1Y9N	ME206N	Dept. Elective	PL3XWN / PL3X9N			
7			PL2XWN / PL2X9N	PL2YWN / PL2Y9N				

Requirements for B.Tech. in Mechanical Engineering:

Category of Courses	Minimum Credits to be Earned
Basic Science Courses (BSC)	20
General Engineering Courses (GEC)	12
Life Skill Courses (LSC)	20
Programme Core Courses (PCC)	48
Dept/Institute Elective Courses (DEC)	24
Internships/Major Project Courses (IPC)	27
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

ME201N MECHANICS OF DEFORMABLE BODIES (2-1-0) 3

Engineering mechanics foundation- Force system, FBD, Reactions, Centroid, and Moment of Inertia, Mechanical properties of materials-stress and strain, Hooke's law, material constants, FOS, Axially loaded members- Statically indeterminate structures, Thermal effects, Strain energy, Plane stress, Principal stresses, Mohr's circle, Torsion of circular bar, Transmission of power by circular shafts, Shear forces and bending moments, Stresses in Beams-Pure and Nonuniform Bending, Deflection of beams.

Merian, J.L., Kraige, L.G. Engineering Mechanics – Statics, 6th Edition, Wiley Publishers, New Delhi, 2008.
James M. Gere, Barry J. Goodno, Mechanics of Materials, 9th Edition, Cengage Engineering, Learning, 2022.

ME202N STRUCTURAL AND FUNCTIONAL MATERIALS (2-1-0) 3

Introduction to Materials Science and Engineering, Broad Classification of Materials, Crystal Structures - Unit Cells, Crystallographic Directions and Planes, Linear and Planar Densities, Crystalline Defects and Imperfections – Point, Line, Planar and Volume Defects, Diffusion Mechanisms and Fick's Laws, Mechanical Behaviour of Materials - Stress–Strain Relationships, Mechanical Behaviour of Materials - Toughness, Hardness, Ductility, Failure Modes – Ductile and Brittle Fracture, Introduction to Fracture Mechanics, Fatigue, Creep, Phase Equilibria, Binary and Eutectic Phase Diagrams, Iron–Iron Carbide System, Phase Transformations, Metals and Alloys – Ferrous and Nonferrous Alloys, Ceramics – Crystal Structure, Properties and Applications, Polymers Structure, Classification, Mechanical and Thermal Behaviour, Processing and Applications, Advanced and Functional Materials – Composites: Structure, Reinforcement and Properties, Semiconductors: Basic Concepts and Applications, Biomaterials: Biocompatibility and Examples, Properties of Materials – Heat and Thermal Conductivity, Magnetic Behaviour, Optical Properties, and Processing and Production Methods.

Callister W.D. and Rethwisch D.G, Material Science and Engineering, 10th Edition, John Wiley & Sons, 2024.
D. R. Askeland, P. P. Fulay, W. J. Wright, and K. Balani, The Science and Engineering of Mate-rials, 7th Edition, Cengage Learning, 2017.

ME203N FLUID MECHANICS (2-1-0) 3

Introduction to Fluid Mechanics and Fundamental Fluid Properties, Fluid Statics including Pressure Measurement, Buoyancy and Floatation, Fluid Kinematics, Conservation of Mass and Conservation of Momentum, Momentum Analysis of Fluid Flow Systems, Dimensional Analysis, Differential Analysis of Fluid Flow, Internal Flows and Flow Through Pipes, Flow Around Immersed Bodies, Boundary Layer Theory, Compressible Flows, Impact of Jets, and Principles of Hydraulic Machinery.

Frank M. White, Fluid Mechanics, Eighth Edition, Tata McGraw Hill Publication, 2017.
Yunus A. Cengel, John M. Cimbala, Fluid Mechanics: Fundamentals and Applications, Fourth Edi-tion, McGraw-Hill Publication, 2018.

ME204N COMPUTER AIDED DRAWING PRACTICE (0-0-6) 3

Introduction to Engineering Drawing Practice and Orthographic Projections, Isometric Projections, Sections of Solids, Development of Surfaces, and Generation of Interpenetrating Curves and Edges Between Revolved Solids through Manual Drafting. Introduction to Computer-Aided Drafting Tools with Demonstration of Engineering Drawing Exercises, Sectional Views of Machine Parts, Thread Profiles, Bolts and Nuts, Rivets and Riveted Joints. Preparation of Assembly Drawings from Part Drawings such as Screw Jack, Swivel Bearing, Fuel Injector, Tail Stock, 6-DOF Robotic Arm, Fuel Injection Pump, Connecting Rod, Gear Pump, and Centrifugal Pump. Derivation of Part Drawings from Assemblies including Drill Jig and Three-Jaw Chuck. Introduction to Geometric Dimensioning and Tolerancing (GD&T), Blueprint Reading, Feature Recognition, Datum References, Tolerance Zones, Feature Control Symbols, Conversion of Physical Mechanical

Components into Drawings, and Drafting of Involute Gear Tooth Profiles and Various Toothed Gear Systems using Computer Drafting Tools.

Gopalkrishna K. R., Engineering Drawing Vol. 1 and Vol. 2 Combined, 30th Edition, Subhas Publications,, 2017.
Bhat N. D., Engineering Drawing, 15th Edition, Charotar Publishing House, Anand, India, 2011.

ME205N MECHANICS OF SOLIDS AND FLUIDS LAB (0-0-6) 3

Tension Tests on Mild Steel and Cast Iron: Stress–Strain Behavior, Yield, Ductility, Brittle Fracture, and Comparative Tensile Response, Compression Tests on Mild Steel and Cast Iron: Stress–Strain Characteristics, Elastic–Plastic Behavior, Compressive Strength, and Failure Modes, Bending Test on Mild Steel Beam: Flexural Strength Determination, Load–Deflection Behavior, and Neutral Axis Observation, Torsion Test on Mild Steel Shaft: Torque–Twist Relationship and Modulus of Rigidity Determination, Impact Testing Using Izod and Charpy Methods: Energy Absorption, Notch Sensitivity, and Fracture Behavior Comparison, Hardness Testing Using Rockwell and Brinell Methods: Result Correlation, Integrated Analysis, Failure Interpretation, and Viva-Voce Evaluation, Viscosity Measurement, Determination of Metacentric Height, Verification of Bernoulli's Theorem, Calibration of Flow Meters (Venturi Meter and Orifice Meter) and Calibration of Pressure Gauges, V-Notch, Pitot Tube, Impact of Jet on Vanes, Reynolds Experiment, Determination of Major and Minor Losses in Pipes, Free and Forced Vortex Flow and Measurement of Drag and Lift Coefficient, Performance Characteristics of Pelton Turbine, Francis Turbine/Kaplan Turbine, and Centrifugal Pump/Reciprocating Pump.

James M. Gere, Barry J. Goodno, Mechanics of Materials, 8th Edition, Cengage Engineering, Learning, 2012.
Yunus A. Cengel, John M. Cimbala., Fluid Mechanics: Fundamentals and Applications, Fourth Edition, McGraw-Hill Publication, 2018.

ME206N MECHATRONIC SYSTEMS (3-0-0) 3

Introduction to Mechatronic Systems, Examples, Concepts and Applications, Sensors and Transducers – Performance Terminologies, Displacement, Position and Proximity, Velocity, Motion, Force, and Liquid Level Sensors, Sensors and Transducers (Continued) – Pressure, Temperature, Light, and Selection of Sensors, Signal Conditioning – Operational Amplifiers, Protection Circuits, Filters, Pulse Modulation, Signal Problems, ADC and DAC, Multiplexers, Pneumatic and Hydraulic Systems – Linear and Rotary Actuators, Pneumatic and Hydraulic Systems (Continued) – Direction, Pressure, and Flow Control Valves, Development of Single-Acting Cylinder Circuits, Solenoid, DC, AC, Stepper, Switched Reluctance and Servo Motors, Motor Selection, Control Systems – Open-Loop and Closed-Loop Systems, Examples and Simple First-Order Mechanical Systems, Microprocessors and Microcontrollers, Interfacing of Input and Output Devices to Microcontrollers, Programmable Logic Controllers – Bit Operations, Logic Operations, Timers, Counters, Sequencers, Grouping Circuits, and Mechatronics Development Case Studies Including Robots, CNC Machines, Medical Systems, and Domestic Applications.

Bolton W., Mechatronics 7thEdition, Pearson Education Ltd. Indian print, 2019.
Devdas Shetty and Richard A Kolk, Mechatronics System Design, Pearson, 2021.

ME251N KINEMATICS AND DYNAMICS OF MACHINERY (2-1-0) 3

Kinematics Fundamentals, Links, Kinematic Pairs, Kinematic Diagrams, Mobility of Planar Mechanisms, Kinematic Analysis of Planar Mechanisms, Kinematics of Cams – Introduction and Construction of Disc Cam Profiles, Kinematics of Gears – Interference in Involute Gears, Methods of Avoiding Interference, Conditions for Minimum Number of Teeth to Avoid Interference, Kinetic Fundamentals, Dynamic Force Analysis of Four-Bar Mechanisms, Balancing of Rotating Machines, Balancing of Reciprocating Machines, Introduction to Flywheels, Introduction to Governors, Introduction to Gyroscopes and Whirling of Shafts, Introduction to Vibrations, Free Vibrations (Damped and Undamped) of Single Degree of Freedom Systems, Forced

Vibrations (Rotating Unbalance and Base Excitation), Vibration Isolation, and Introduction to Two Degree of Freedom Systems, Natural Frequencies, and Mode Shapes.

Rattan S.S., Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 5th Edition, 2019.
Amitabha Ghosh and Asok Kumar Mallik, Theory of Mechanisms and Machines, 3rd Edition, East West, 2011.

ME252N ENGINEERING THERMODYNAMICS (2-1-0) 3

Fundamental Concepts, Systems, Temperature, Heat and Work, Properties of Pure Substances, Zeroth and First Laws of Thermodynamics, First Law Applications for Closed and Open Systems, Introduction to Entropy, Entropy Analysis, Available and Unavailable Energy, Second Law Efficiency, Criteria for Spontaneous Change and Thermodynamic Relations, Multicomponent Systems, Chemical Potential and Chemical Equilibrium, Analysis of Ideal Cycles including Otto, Diesel, and Dual Cycles, Gas Turbine and Power Plant Cycles including Brayton and Rankine Cycles, Refrigeration Cycles including Vapour Compression and Vapour Absorption Cycles, and Psychrometry.

Çengel, Y. A., Boles, M. A., & Kanoğlu, M., Thermodynamics: An Engineering Approach, 10th ed., McGraw-Hill Education, 2023.
Nag, P. K. and De, S., Engineering Thermodynamics. Seventh Edition, McGraw Hill Education, 2024.

ME253N MANUFACTURING PROCESSES (2-1-0) 3

Steps Involved in Making a Casting, Pattern Materials, Allowances and Pattern Types, Cores – Purpose, Core Making, Types of Cores, Core Prints and Chaplets, Principles of Gating, Gating Systems and Gating Ratio, Risers – Functions, Types and Design Considerations, Melting Practices, Solidification of Pure Metals and Alloys, Casting Processes including Shell Moulding, Investment Casting and Die Casting, Centrifugal Casting – Advantages and Applications, Casting Defects – Causes and Remedies, Plastic Deformation Mechanism, Yield Criteria, Flow Curve and Strain Hardening, Friction and Lubrication in Metal Forming, Classification of Metal Forming Processes, Analysis of Rolling, Forging, Extrusion and Drawing of Rods, Wires and Tubes, Force Calculations in Metal Forming Processes, Metal Forming Defects, Sheet Metal Cutting and Forming Operations, Work and Tool Holding Devices – Dies, Jigs and Fixtures, High Strain Rate Forming, Welding Principles, Classification and Thermal Effects in Welding, Metallurgy of Fusion Welds, Process Details and Applications of Metal Arc Welding Processes, Gas Welding, Resistance Welding, Solid-State Welding Processes, Laser Welding, Soldering and Brazing, Assessment of Weldability of Metals, Weldability Testing, Residual Stresses in Welding, Welding Defects – Causes and Remedies, Design for Welding, Classification of Machine Tools, Conventional Machine Tools – Lathe, Milling, Drilling, Shaping/Planing, Broaching, Grinding, Honing and Lapping, CNC Machines – Controlled Axes, Basics, Types and Configurations, Mechanics of Metal Removal Process, Force Analysis, Merchant's Circle Diagram and Analysis, Ernst Merchant's Solution, Shear Angle Relationships, Friction, Economics of Machining, Heat Generation in Machining, Cutting Tool Wear, Tool Life and Machinability.

Kalpakjian S and Schmid S R, Manufacturing Engineering and Technology, 7th Edition, Pearson Education, 2014.
Amitabha Ghosh and Asok Kumar Mallik, Manufacturing Science, East-West Press, 2nd edition, 2010

ME254N MACHINING, TRAINING AND APPLIED ENGINEERING LAB (0-0-6) 3

Fitting, Carpentry, Welding Processes, Welding and Casting Simulator, Sheet Metal Operations, Foundry Operations, Lathe Operations including Centre Drilling, Facing, Turning, Taper Turning and Profile Turning, Lathe Operations including Grooving, Knurling, Thread Cutting, Boring and Eccentric Turning, Shaping, Milling, Spur and Helical Gear Cutting, Tool Dynamometer, Grinding and Drilling, CNC Milling and CNC Turning, CNC Wire Electrical Discharge Machining (WEDM), CNC Laser Engraving, and Polymer-Based 3D Printing Techniques.

S. K. Hajra Choudhury, A. K. Hajra Choudhury and Nirjhar Roy, Elements of Workshop Technolo-gy: Volume 1 & 2, 12th ed. New Delhi, India: Media Promoters & Publishers Pvt. Ltd., 2018.
P. N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, 4th ed. New Delhi, In-dia: McGraw Hill Education, 2013.

ME255N COMPUTER-AIDED ENGINEERING AND DYNAMICS LAB (0-0-6) 3

CAE: Static Analysis of Beam, Static Analysis of Plate, Shell and a 3D Machine Component, Heat Transfer and Thermal Stress Analysis of Plate, Shell and 3D Components, Free Vibration Analysis of Beam, Plate and 3D Machine Components including Natural Frequencies, Mode Shapes and Different Boundary Conditions, Transient and Forced Vibrations of Beam and Plate, Kinematic and Dynamic Analysis of Planar Mechanisms, Kinematic and Dynamic Analysis of Spatial Mechanisms, Free Vibration of Spring–Mass–Damper Single Degree of Freedom Systems, Dynamics of Governors including Porter, Watt, Proell and Hartnell Governors, Critical Speed of Shafts and Gyroscope Experiments, Cam Profile and Follower Response with Observation of Cam Jump, Determination of Velocity Ratio, Slip and Efficiency, Tension Measurement in Belts, Static Balancing of Rotating Masses, and Dynamic Balancing of Rotors.

Rattan S.S., Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 5th Edition, 2019.
David H. Myszka, Machines & Mechanisms: Applied Kinematic Analysis, 4th Ed, Pearson Education India, 2015.

ME261N COMPUTATIONAL METHODS IN ENGINEERING (3-0-0) 3

Linear Algebra and Solution of Differential Equations Using Numerical Differentiation, Applications of One-Dimensional Boundary Value Problems, Gauss Elimination and LU Decomposition, Eigenvalue Problems with Applications to Spring–Mass Systems, Normal Modes and Natural Frequencies, Solution of Nonlinear Algebraic Equations Using Bisection and Fixed-Point Iteration Methods, Newton–Raphson and Secant Methods, Regression and Curve Fitting Using the Method of Least Squares, Linear Regression and Goodness of Fit, Numerical Integration Using Trapezoidal, Simpson's and Gauss Quadrature Rules, Double Integrals Using Gauss Quadrature, Interpolation Using Polynomial, Lagrange and Hermite Interpolation Techniques in One, Two and Three Dimensions, Ordinary Differential Equations and Initial Value Problems, Finite Difference Methods in the Time Domain, Convergence and Stability Analysis, Runge–Kutta, Houbolt, Wilson and Newmark-Beta Methods, Classification of Partial Differential Equations, Elliptic, Parabolic and Hyperbolic Equations, and Engineering Case Studies.

Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press, 1st Edi-tion, 2007.
S. P. Venkateshan, Prasanna Swaminathan, Computational Methods in Engineering, Springer In-ternational Publishing; 2023rd Edition, 2024.

ME262N COMPOSITE MATERIALS (3-0-0) 3

Basic Concepts and Characteristics of Composite Materials, Definition and Characteristics of Composite Materials, Overview of Advantages and Limitations of Composite Materials, Composite Applications in Science and Technology, Types and Classification of Composite Materials, Processing of Fibres, Processing of Matrix Materials, Micromechanical Behaviour of a Lamina, Macromechanical Behaviour of a Lamina, Micromechanical Behaviour of a Laminate, Macromechanical Behaviour of a Laminate, Processing of Polymer Matrix Composite Materials, Processing of Metal Matrix Composite Materials, Processing of Ceramic Matrix Composite Materials, and Testing of Composite Materials.

Madhujit Mukhop, Mechanics of Composite Materials, 1st Edition, Universities Press, 2004
Robert M. Jones, Mechanics of Composite Materials, 2nd Edition, McGraw-Hill, 2015.

ME263N WIND ENERGY (3-0-0) 3

Historical Development of Wind Energy, Modern Wind Turbines, Current Status and Future Prospects, Sources and Characteristics of Wind, Wind Resource Assessment, Wind Turbine Energy Production Estimates Using Statistical Techniques, Wind Prediction and Forecasting, Wind Measurement and Instrumentation, Wind Turbine Aerodynamics Including One-Dimensional Momentum Theory, Betz Limit, Ideal Horizontal Axis Wind Turbine with Wake Rotation, Blade Element Theory and Strip Theory, Blade Geometry, Effects of Drag and Blade Number on Optimum Performance, Tip Losses, Tip Loss Correction and Blade Root Losses, Wind Turbine Performance Including Wind Machine Parameters, Cp-λ Characteristics, Effects of Solidity on Performance, CQ-λ and CT-λ Curves, Constant and Variable Speed Operation, Power Control, Stall and Pitch Regulation, Operational Characteristics, Wind Turbine and Component Design, Siting and Wind Farm Design, Visual and Landscape Assessment, Electrical and Control Systems Including Synchronous and Induction Generators, Variable Speed Generators, Power Collection Systems and Earthing of Wind Farms, Economic Assessment Including Annual Energy Output, Payback Period, Capital Recovery Factor, Depreciation, Life Cycle Costing and Project Appraisal, Environmental and Social Issues Including Biological, Avian, Visual, Sound and Communication Impacts, Operation of a Low-Speed Wind Tunnel, Instrumentation for Measuring Force, Velocity and Pressure, Pressure Distribution Over an Airfoil, Measurement of Lift and Drag Forces, Wake Velocity Profile, Flow Visualization Over an Airfoil, and Mini Project.

J.F. Manwell, J.G. McGowan, and A.L. Rogers., Wind Energy Explained, Theory, Design and Application, Second Edition John Wiley & Sons Inc., 2010.
Sathyajith Mathew., Wind Energy Fundamentals, Resource Analysis and Economics Springer-Verlag Berlin Heidelberg, 2006.

ME264N AERODYNAMICS (2-1-0) 3

Introduction to Aerodynamics, Conservation Laws, Dimensional Analysis and Dynamical Similarity, Potential Flows and Boundary Layers, Airfoil Nomenclature, Aerodynamic Coefficients and the Kutta–Joukowski Theorem, Conformal Mapping and Joukowski Airfoils, Kutta Condition, Thin Airfoil Theory and Starting Vortex, Finite Wing Theory and Induced Drag, Viscous Effects and High-Lift Flows, Lifting Line Theory, Vortex Lattice Method and Delta Wings, Compressibility Effects and Supersonic Flows, Unsteady Aerodynamics, Applications of Artificial Intelligence and Machine Learning in Aerodynamics, Feature Extraction, Reduced-Order Modelling, Physics-Informed Neural Network Models, and Aerodynamic Design Optimization.

Anderson, J. D., Cadou, C. P., Fundamentals of Aerodynamics, 7th ed., United Kingdom: McGraw Hill, 2023.
McBain, G. D., Theory of Lift: Introductory Computational Aerodynamics in MATLAB/Octave, Elsevier, 2012.

ME265N MATERIALS SELECTION FOR MANUFACTURING (2-1-0) 3

Overview of Material Classes and Properties, Introduction to Materials Selection, Design-Driven and Science-Driven Selection, Material Property Charts Including Young's Modulus, Strength and Toughness, Interpretation and Use of Ashby Charts, Selection Strategies Including Screening and Ranking Methods and Multi-Objective Optimization, Manufacturing Constraints and Process–Material Compatibility in Casting, Machining and Additive Manufacturing, Design for Manufacturability Considerations, Cost Modelling in Material and Process Selection, Process Attributes and Selection Maps, Sustainability and Eco-Design, Life Cycle Assessment, Material Efficiency, Life Cycle Analysis and Recyclability, Advanced Materials Including Hybrid Materials, Composites and Sandwich Structures, Materials for Extreme Environments Including High-Temperature and Corrosive Conditions, Emerging Materials Including Biomaterials, Smart Materials, Smart Fabrics, Optical Materials, Photonic Materials and Metamaterials.

M. F. Ashby and D. R. H. Jones, Engineering Materials 1: An Introduction to Properties, Applica-tions and Design, 5th edition, Butterworth-Heinemann, 2019.
M. F. Ashby and D. R. H. Jones, Engineering Materials 2: An Introduction to Microstructures and Processing, 5th edition, Butterworth-Heinemann, 2012.

ME266N ENGINEERING PRODUCT DEVELOPMENT (3-0-0) 3

Product Planning and Opportunity Identification, Generic Process of Product Development, Concept Development and Generation, Ideation Tools Including TRIZ, Concept Selection and Testing, Product Architecture, Design for Manufacture, Assembly and Supply Chain, Design for Sustainability, Prototyping – Purposes, Types and Strategies, Virtual and Physical Prototypes, Physical Prototyping Methods Including Rapid Prototyping, Reverse Engineering, Product Life Cycle Management, and Product Development Case Studies.

K T Ulrich and S D Eppinger, Product Design and Development, 7ed McGraw Hill, 2020.
K Otto and K Wood, Product Design, Pearson Education, Inc. 2001

ME267N CONTROL SYSTEMS (3-0-0) 3

Introduction to Control Systems, Dynamic Systems, Open-Loop and Closed-Loop Systems, Regulators and Servo Controllers, Mathematical Modelling of Linear Mechanical Systems, Rotary Mechanical Systems, Gear Systems with and without Losses, Mathematical Modelling of Electrical Systems, Analogies Between Mechanical and Electrical Systems, Electromechanical Systems Including Field-Controlled and Armature-Controlled DC Motors, Solenoids and AC Motors, Block Diagram Reduction and Signal Flow Representation of Systems, State-Space Representation of Mechanical and Electrical Systems, Analysis of MIMO and SISO Systems, Time Response Analysis of Control Systems, Standard Test Signals, Steady-State Analysis of Type 0, Type 1 and Type 2 Systems, First-Order and Second-Order Systems, Time-Domain Specifications for Underdamped, Critically Damped and Overdamped Systems, Stability Criteria and Stability Analysis, Construction and Analysis of Root Locus, and Fundamentals of Frequency Domain Analysis.

Norman S Nice, Control System Engineering, 8th Edition, John Wiley and sons, Inc.,2025
Linear Control Systems in Engineering: Basics and Beyond by Noman Jafri, Imran Shafi, Uzair Khaleeq uz Zaman & Atal Anil Kumar — 1st Edition, Routledge, 2026.

ME268N MICROSYSTEMS TECHNOLOGY (3-0-0) 3

Miniaturization Fundamentals and Evolution, Microsystems and MEMS Products, Markets and Applications, Microsensors and Actuators, Working and Transduction Principles for Physical, Chemical and BioMEMS Applications, Thin Films and Materials Including Silicon, Gold, Silver and Polymers with Case Studies, Scaling Fundamentals, Microfabrication Technologies Including Deposition and Etching Processes, Photolithography, Bulk and Surface Micromachining, LIGA and Other Microfabrication Processes, Design Considerations and CAD for Coupled Field Analysis, Microsystems Packaging and Integration, and Case Studies on MEMS Design and Applications.

Tai-Ran Hsu, "MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering", Wiley, 2020.
Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology", CRC press-3rd Edn, 2018.

ME301N DESIGN OF MACHINE ELEMENTS (2-1-0) 3

Introduction to Machine Design, Failure Theories, Design for Static Loading in Two-Dimensional and Three-Dimensional Cases, Curved Beams and Stress Concentration, Design of Shafts and Keys, Mechanical Springs including Helical and Concentric Springs, Design for Fatigue Loading, Journal and Roller Bearings, Belt Drives including Flat and V-Belts, Introduction to Gears and Design of Spur Gears, Design of Helical and Bevel Gears, Design of Gearboxes, Clutches including Single Plate, Multi-Disc, Cone and Centrifugal Clutches, and Design of Brakes.

RL Norton – Machine Design, An integrated approach, 5th Edition, Pearson Education Asia, 2018.
J.E. Shigley and Mische Mech. Engineering Design, Tata McGraw Hill, 5th Edition 2020.
K. Mahadevan and K. Balaveera Reddy- Design data Hand Book, 4th Edition, CBS, 2019.

ME302N MODERN MANUFACTURING AND METROLOGY (3-0-0) 3

Introduction to Modern Manufacturing Systems and the Evolution of Manufacturing Technologies, Classification of Advanced Manufacturing Processes and Their Applications, Fundamentals and Principles of Non-Traditional Manufacturing Processes and Their Role in Machining Complex and Hard-to-Machine Materials, Overview of Additive Manufacturing Concepts, Process Characteristics, Material Compatibility, Advantages, Limitations and Industrial Applications, Introduction to Hybrid Manufacturing Processes Combining Additive and Subtractive Techniques for Improved Productivity and Component Quality, Fundamentals of Micro and Nano-Manufacturing Methods and Challenges in Achieving Dimensional Accuracy at Small Length Scales, Introduction to Electronics Manufacturing, Precision Fabrication Requirements, Packaging Concepts and Manufacturing Challenges in Electronic Components, Fundamentals of Engineering Metrology, Measurement Standards, Accuracy, Precision, Errors and Calibration Concepts, Measurement of Surface Roughness, Form and Dimensional Characteristics Using Conventional and Advanced Metrology Techniques, Principles of Limits, Fits, Tolerances and Geometric Dimensioning and Tolerancing (GD&T) for Functional Product Design, Contact and Non-Contact Measurement Systems Including Coordinate Measuring Machines and Optical and Vision-Based Inspection Systems, In-Process and Post-Process Inspection Techniques, Sensor Integration and Data Acquisition for Quality Monitoring in Manufacturing, Introduction to Digital Metrology, Industry 4.0 Concepts, Real-Time Inspection Systems and Smart Manufacturing Applications.

V.K. Jain, Advanced Machining Processes, Allied Publishers, 2007.
Kalpakjian and Schmid, Manufacturing Engineering and Technology, Pearson Education, 7th Edi-tion, 2014.
R.K. Jain, Engineering Metrology, Khanna Publishers, 2008.

ME303N HEAT TRANSFER (2-1-0) 3

Fourier Law of Heat Conduction, General Heat Conduction Equation, One-Dimensional Steady-State Heat Conduction in Plane Walls, Cylinders and Spheres, Critical Thickness of Insulation, Multidimensional Heat Conduction, Practical Problem Analysis, Fin Heat Transfer, Transient Heat Conduction, Forced Convection in External and Internal Flows, Natural Convection, Non-Dimensional Analysis of Convection Heat Transfer, Heat Exchangers, Introduction to Radiation Heat Transfer, Radiative Properties, Radiation Heat Transfer in Non-Participating Media and Its Practical Applications, Boiling and Condensation Heat Transfer, and Numerical Heat Transfer.

Çengel, Y. A., and Ghajar, A. J., Heat and Mass Transfer-Fundamentals and applications, 6th ed., McGraw Hill Series, 2020.
Lavine, A. S., Bergman, T. L., Incropera, F. P., and DeWitt, D. P., Fundamentals of Heat and Mass Transfer, 8th ed, Wiley, 2020.

ME304N THERMAL ENGINEERING LABORATORY (0-0-6) 3

Calorimeter Experiments for Determining the Calorific Values of Solid, Liquid and Gaseous Fuels, Morse Test, Valve and Port Timing Diagrams, Heat Balance Study on a Two-Stroke Diesel Engine, Load Test on a Single-Cylinder Four-Stroke Air-Cooled CI Engine, Performance Testing of a Single-Cylinder Four-Stroke CI Engine and Measurement of Compression Ratio, Performance Analysis of Parallel and Counter-Flow Heat Exchangers and Two-Stage Compressors, Performance Test on a Centrifugal Blower, Flash and Fire Point Experiments, Performance Evaluation of a Four-Stroke Diesel Engine, Thermocouple Calibration, Determination of Emissivity of a Test Plate, Boiling and Condensation Experiments, Heat Transfer Experiments Including Thermal Conductivity of a Metal Rod and Heat Conduction Through a Composite Wall, Natural and Forced Convection Heat Transfer, Heat Transfer from a Pin Fin, and Computational Flow and Heat Transfer Experiments.

Çengel, Y. A., Boles, M. A., & Kanoğlu, M., Thermodynamics: An Engineering Approach, 10th ed., McGraw-Hill Education, 2023.

Çengel, Y. A., and Ghajar, A. J., Heat and Mass Transfer-Fundamentals and applications, 6th ed., McGraw Hill Series, 2020.
John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, 2nd Edition, McGraw-Hill Education, 2022.

ME305N METROLOGY, MEASUREMENTS AND MECHATRONIC LAB (0-0-6) 3

Experiments on Linear and Angular Measurements, Calibration of Measuring Instruments, Flatness and Straightness Measurement, Screw Thread Measurement, Involute Gear Tooth Measurement, Tool Signature and Wear Measurement, Surface Roughness Measurement, Coordinate and Roundness Measurement, Experiments on Proximity Sensors Including Resistive, Capacitive, Inductive, Light and Image Processing Sensors, Development of Pneumatic Circuits for Given Applications, Development of Electro-Pneumatic Circuits for Given Applications, Development of Hydraulic Circuits for Given Applications, Development of Electro-Hydraulic Circuits for Given Applications, Introduction to PLCs, Basic Logic Operations, Use of Counters and Timers, Arithmetic Operations in PLC-Based Automation, Automation Experiments on Buffering and Sorting, Automation Experiments on Pick-and-Place Systems, Colour Detection, and Industrial Case Studies.

Basics of PLC and Hydraulics manual.
David G. Alciatore and Michael B. Histand. Introduction to Mechatronics and Measurement Systems. McGrawHill; 5th Edition 2019

ME351N FINITE ELEMENT METHOD (3-0-0) 3

Introduction to Numerical Simulation, Need for Weighted Residual Statement, Weighted Residual Methods, Variational Formulation, Weighted Integral and Weak Formulations, Ritz Method, Finite Element Formulation for Axial Bar and Torsional Systems under Static Loading, Finite Element Formulation for Heat Transfer and Fluid Mechanics Problems, Finite Element Formulation for Bending of Beams under Static Loading, Free Vibration, Transient and Steady-State Response of Bar and Torsional Systems, Dynamic Analysis of Beams, Numerical Integration, Iso-Parametric Formulation for One-Dimensional Cases, Finite Element Formulation for Plane Stress, Plane Strain and Axisymmetric Problems Using CST Elements, Dynamic Analysis of Structures Using CST Elements, Iso-Parametric Formulation for Two-Dimensional Cases, Derivation of Shape Functions Using Lagrange Polynomials, Coordinate Transformation Using Jacobian, Two-Dimensional Elasticity Problems Using Iso-Parametric Elements and Numerical Integration, Error and Patch Tests, and Engineering Case Studies.

P Seshu, Textbook of Finite Element Analysis, 1st Edition, PHI, 2003.
J. N. Reddy, An Introduction to Finite Element method, 4th Edition, McGraw- Hill, 2020.

ME352N DEFENCE SCIENCE TECHNOLOGY (2-1-0) 3

Introduction to Defence Science Technology, Weapons systems: Ballistics, missiles, and guided systems, Anti-missile system: working principle and its type, Robotics and autonomous systems in defence, Military vehicle ergonomics, Soldier workload and fatigue, Injury Mechanisms (Ballistic, Blast, Impact (TBI)), Soldiers injury and its long term effects, Military helmets, jackets and its types, Design of body armor and protective gears, Metamaterial and its application in defence, Exoskeletons and bio-enhancements, Case studies, Mini Project

Richard A. Bitzinger, Introduction to Modern Defence Analysis, 1st Edition, Praeger Publishers Inc, 2009.
Anthony M. J. Bull, Blast Injury Science and Engineering, 3rd Edition, Springer, 2023.

ME353N INTRODUCTION TO AIRCRAFT STRUCTURE (2-1-0) 3

Brief history-components of an airplane and their functions, Different types of flight vehicles and classifications, Basic instruments for flying physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment, Different types of drag, Aerodynamic forces on

aircraft, Classification of NACA aerofoils, Aspect ratio, wing loading, Mach number, Centre of pressure and aerodynamic centre, Aerofoil characteristics, Lift and drag curves, Typical wing and fuselage structure, Aircraft Materials

Anderson, J.D., Introduction to Flight, 6th Edition, McGraw-Hill, 2008.
Kermode, A.C., Flight without Formulae, 5th Edition, Pearson, 2004.

ME354N THEORY OF ELASTICITY (2-1-0) 3

Introduction to Elasticity, Stress Analysis: Components of stress, 2D/3D stress analysis, Equations of equilibrium, Numerical problems, Principal stresses, Mohr's diagram in three dimensions, boundary conditions, Strain Analysis: strain components, strain displacement equation, compatibility equations, Numerical examples, Stress-strain relation, general equation of elasticity, Numerical examples, Existence and uniqueness of solution, Saint-Venant's principle, principle of superposition, and reciprocal theorem, Analysis of Axisymmetric problems: stresses in rotating hollow/solid discs, Airy's stress function to solve a two-dimensional problem, Torsion of prismatic bars: Circular, elliptical, triangular, and square/rectangular cross-sections, Soap film analogy, membrane analogy, and Numerical examples, Torsion of Thin-walled Sections, Thick and thin-walled cylinders. Introduction to beam theory and displacement equations, Introduction to plate theory and displacement equations

L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw-Hill Book Company, 2017
Timoshenko and Goodier, Theory of Elasticity, McGraw-Hill Book Company, 2019

ME355N COMPUTATIONAL FLUID DYNAMICS (2-1-0) 3

Fundamental concepts of Computational Fluid Dynamics (CFD), CFD Historical review applications, Derivation of the fluid flow and heat transfer governing equations based on various fluid flow models, Mathematical aspects of the fluid dynamic equations classification methods, Implementation of the finite difference method for fundamental advection diffusion advection-diffusion partial differential equations, Implementation of the finite volume method for fundamental advection diffusion advection-diffusion partial differential equations, Stability consistency and convergence issues, Numerical schemes for two dimensional Navier–Stokes equations like Lax-Wendroff method, MacCormacks method SIMPLE Algorithm, Implementation of boundary conditions. Various meshing methods, Turbulence Modelling in CFD, Use CFD software to model relevant engineering flow problems CFD Projects Discussion Hands on Training

John D. Anderson Jr. Computational Fluid Dynamics The Basics with Applications. McGraw–Hill International Edition, 1995.
M. N. Ozisik, Finite Difference Methods in Heat Transfer, 1st Edition, CRC-Press, 1994.

ME356N FUEL CELL SCIENCE AND TECHNOLOGY (2-1-0) 3

Introduction to electrochemical conversion systems, Overview of fuel cell types, Fuel cell thermodynamics, Fuel cell reaction kinetics, Fuel cell charge and mass transport, Fuel cell modelling and characterization, Fuel cell systems, Low and High temperature fuel cell systems', Fuel cell system design, Hands-on training on membrane electrode assemblies, Fuel cell performance and durability test - 1, Fuel cell performance and durability test – 2

Ryan O'Hayre, Suk-Won Cha, Whitney Colella, Fritz B. Prinz, Fuel Cell Fundamentals, 3rd Edition, Wiley, 2016.
Frano Barbir, PEM Fuel Cells: Theory and Practice, 2nd Edition, Academic Press, 2013.

ME357N ENERGY CONVERSION AND STORAGE (3-0-0) 3

Real Gases, Non Reactive Mixtures, Entropy of Mixing, Ideal Work of Separation, Stoichiometry & Mass Conservation, Energy Balance in Chemical Reactions, Hydrocarbon Combustion, Hydrogen Production:

Steam/Methane Reforming, Dissociation of Water and CO2, Coal Gasification Reactions, Electrochemical Thermodynamics, Fuel Cells at Finite Current, Electrolysis and Energy Storage, Battery Energy Storage, Gas Separation Technologies, Solar Photovoltaics, Solar Thermal Energy, Wind Energy, Biomass Energy, Nuclear Energy

J.F. Manwell, J.G. McGowan, and A.L. Rogers., Wind Energy Explained, Theory, Design and Application, Second Edition John Wiley & Sons Inc., 2010.
Sathyajith Mathew., Wind Energy Fundamentals, Resource Analysis and Economics Spring-er-Verlag Berlin Heidelberg, 2006.

ME358N MEASUREMENT METHODS IN THERMAL ENGINEERING (2-1-0) 3

Flow Properties and Basic Principles, Measuring Systems, Measurement Uncertainty, Signal Conditioning, Thermal Anemometry, Optical Experimentation Principles, Flow Visualization Techniques, Fluid Mechanical Apparatus: Wind Tunnels, Water Tunnels, Towing Tank, Measurement of Flow Pressure, Flow Rate, Measurement of Local Flow Velocity, Wall Shear Stress, Viscosity, Measurement of Temperature, Humidity, Heat Flux, Measurement of Thermal Conductivity, Emissivity, Measurement of Chemical Composition, Diffusion Coefficient, Applications of AI/ML: Measurement Noise Reduction, Data-Driven Calibration, Super-Resolution Techniques. Creating Digital Twin of Experiments, ML-Informed Experimental Design

Holman, J. P., Experimental Methods for Engineers, 8th ed., United States: McGraw-Hill/Connect Learn Succeed, 2012.
Tavoularis, S., Nedić, J., Measurement in Fluid Mechanics, 2nd ed., United Kingdom: Cambridge University Press, 2024.

ME359N FUNDAMENTALS OF ADDITIVE MANUFACTURING (2-1-0) 3

Introduction to Additive Manufacturing - History and evolution of AM, Comparison with conventional manufacturing, AM process chain, Pre-Processing Fundamentals - CAD models for AM, tessellation concepts, STL file structure and manipulation, Support structures and orientation planning, Classification of Additive Manufacturing processes, Powder Bed Fusion Processes – Laser and electron beam based, Directed Energy Deposition Processes – Powder and Wire based processes with different heat sources, Binder Jetting processes, Sintering and densification considerations, Material Jetting Processes, Polymer and Metal Fused Filament Fabrication, Process parameters in FFF, Ultrasonic Additive Manufacturing and Vat Photopolymerization processes, Characteristics of feedstock used in Additive Manufacturing Processes – Powder, wire, filament, resin, inks etc., Metal-based Additive Manufacturing – Process parameters, defects, microstructure and in-situ process monitoring, Post-Processing of AM Parts - Support removal strategies, Heat treatments and HIP, Residual stress mitigation, Design for Additive Manufacturing (DfAM), Lightweighting and lattice structures, Bio-inspired and architected materials

Gibson, D. W. Rosen, B. Stucker, and M. Khorasani, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping to Direct Digital Manufacturing, 3rd edition, Springer, 2020.
C. K. Chua and K. F. Leong, 3D Printing and Additive Manufacturing: Principles and Applica-tions, 5th edition, World Scientific, 2021.

ME360N MICRO AND NANO MANUFACTURING (3-0-0) 3

Overview of Macro/Meso scale manufacturing, Need for miniaturization, Introduction to miniaturization, Classification of miniaturized manufacturing processes, Micro molding and Micro welding: conceptual realization, materials and process parameters selection, performance characteristics, advantages, limitations, and applications, Micro Extrusion: conceptual realization, materials and process parameters selection, performance characteristics, advantages, limitations, and applications. Introduction to advanced micro-subtractive processes, Wet, Dry Plasma and Cryogenic Types, and Deep Reactive Ion Etching processes: conceptual realization, materials and process parameters selection, performance characteristics, advantages,

limitations, and applications, Mechanical based advanced micro subtractive processes: conceptual realization, materials and process parameters selection, performance characteristics, advantages, limitations, and applications, Thermal based advanced micro subtractive processes: conceptual realization, materials and process parameters selection, performance characteristics, advantages, limitations, and applications, Electrochemical based advanced micro subtractive processes: conceptual realization, materials and process parameters selection, performance characteristics, advantages, limitations, and applications, Introduction to Nanotechnology, Fundamentals of nano structured materials/features, Classification of nano structured materials/features, Glimpse of nanomaterial applications, Wire Explosion, Inert Gas Condensation, Sputtering and Submerged Arc Discharge: conceptual realization, mechanism of nano features manufacturing, advantages, limitations, and their product applications, Combustion Flame, Laser ablation, Micro-EDM and Micro-Electro Chemical Discharge Machining: Deep UV and X-ray based Nanolithography: conceptual realization, Mechanism of nano structured materials/features manufacturing, advantages, limitations and their product applications, Deep UV and X-ray based Nanolithography: conceptual realization, mechanism of nano structured materials/features manufacturing, advantages, limitations and their product applications. Illustration on Nano structured materials Characterization: Size, Shape and Distribution, Chemical Composition, Crystal Structure, Concentration, Thermal Conductivity, Viscosity, and other application characteristics

V. K. Jain, Micromanufacturing Processes, 1st edition, CRC Press, 2012.
Guozhong Cao and Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, 2nd edition, World Scientific Publishing, 2011.

ME361N OPERATIONS RESEARCH (3-0-0) 3

Define Operations Research and formulate Linear Programming Problems (LPP) to model industrial resource allocation and optimization challenges, Apply graphical solution methods and the Simplex Algorithm to solve multi-variable maximization and minimization linear programming problems, Conduct sensitivity analysis to evaluate how changes in model parameters impact the optimality and stability of LPP solutions, Solve transportation and assignment problems using the Vogel's Approximation Method, Optimize routes for the Travelling Salesman Problem, Analyze multi-stage decision processes using Dynamic Programming to find optimal solutions for complex, recursive engineering problems, Apply Game Theory principles, including the dominance concept and saddle point methods, to determine optimal competitive strategies, Characterize waiting line systems using Poisson arrival rates, Exponential service times to optimize service facility economy, Develop simulation models using the Monte Carlo technique to analyze stochastic waiting line situations and industrial processes, Construct project networks using CPM and PERT analysis to schedule tasks and identify critical paths in engineering projects, Calculate total, free, and independent floats to manage resource flexibility and perform network crashing for project acceleration. Formulate and solve Non-Linear Programming problems where objective functions or constraints exhibit non-proportional relationships between variables

Frederick S. Hillier and Gerald J. Lieberma, Introduction to Operations Research, 11th edi-tion, McGraw-Hill Education, 2021
Taha H.A., Operations Research – An Introduction, 7th Edition, Prentice Hall Pub, 2002.

ME362N ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR MECHANICAL ENGINEERS (3-0-0) 3

Introduction, History of Artificial Intelligence, Need for AI, Introduction to Machine Learning, Mathematical Basics: Linear Algebra, Probability, Computational Basics – Numerical computation and optimization, Introduction to Machine learning packages, Supervised Learning Basics, Supervised Learning: Classification, Model evaluation, Advanced Supervised Techniques, Unsupervised Learning, Probabilistic and Generative Models, Deep Learning and, Convolutional Networks, Reinforcement Learning, ML in Design, Optimization, Predictive Maintenance and Materials Science, Robotics, Ethical issues

Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, The MIT Press, 2016.
Christopher M Bishop, Pattern Recognition and Machine Learning, Springer Publications, 2013.

ME363N SEMICONDUCTOR CHIP MANUFACTURING (3-0-0) 3

Fundamentals of semiconductor chips and applications, Semiconductor fab basics and equipments, Semiconductor Substrates, Contamination and Clean room protocols, Diffusion, ion implantation, physical and chemical thin film deposition, Resist based optical, electron beam lithography, Wet and dry etching processes, Wafer Polishing, bonding, process integration, Semiconductor packaging, Design for manufacturability, Sustainability aspects, Case study-1, 2, 3

Peter Van Zant, "Microchip Fabrication: A Practical Guide to Semiconductor Processing", McGraw Hill, 6th edn., 2013.
Gary S. May and Costas J. Spanos, "Fundamentals of Semiconductor Manufacturing and Process Control", Wiley-IEEE Press, 2006.

ME364N AUTOMATION SYSTEMS (3-0-0) 3

Introduction to Automation in Production System: Principles and Strategies of Automation, Single-Station Manufacturing Cells analysis, Automated Production Lines analysis, Automated Assembly Systems and its analysis, Lean and Just-In-Time Production Systems, Group Technology, Cellular Manufacturing, Flexible Manufacturing Cells and Systems, Introduction to Industry 4.0, Comparison between industry 4.0 and traditional automation, Applications of Industry 4.0, Design requirements of Industry 4.0, Drivers of Industry 4.0, Smart Business Model, IIoT, Prerequisites of IIoT, Basics of Cyber-Physical Systems, Design of industrial Internet systems, Applications of IIoT, Business models of IoT and IIoT, Augmented reality; Virtual reality, Smart factories: characteristics, technologies used, Case study-1 and 2

M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson, 2015.
Misra, Sudip, Chandana Roy, and Anandarup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0, 1st Edition, CRC Press, 2021.

ME365N ROBOTIC MANIPULATORS – MODELLING TO HARDWARE (3-0-0) 3

Introduction to Robotic Manipulators – Classification, Synthesis of mechanisms (Type, number and dimensional), Understanding various terminologies in Robotics – Pose, Degree of Freedom, Kinematics and Dynamics, Mechanism analysis using open-source GIM software, Understanding transformation matrices – Frame transformations, Euler Angles, Winkel and Cardan angles, Introduction to MATLAB for frame transformations, Kinematic modelling – Modelling using basic trigonometric relationships, Kinematic modelling using MATLAB, Kinematic modelling – Denavit-Hartenberg method, Kinematic modelling using MATLAB – Peter Corke Toolbox, Kinematic modelling of parallel robotic manipulators - Loop closure equations for closed mechanisms, Workspace analysis using MATLAB, Dynamic Modelling – Euler-Lagrangian Approach, Demonstration of Multi-Physics modelling software for robot dynamics, Dynamic Modelling – Newton-Euler Approach, Dynamic modelling using MATLAB – Introduction to SIMULINK, Path planning – Joint space schemes, Introduction to PYTHON (RPI), Sensors, Actuators and Interfacing – Introduction to various sensors and actuators, smart sensors, characteristics, Breadboard sensor integration and programming, Control - Introduction to basic controllers, intelligent controllers, Simulation in PYTHON, Robotic system integration - Design a robotic manipulator to trace a predefined path - Integration of hardware and software, Case Study 1 and 2.

Craig, John J. "Introduction to robotics: mechanics and control," Vol. 3. Upper Saddle River: Pearson Prentice Hall, 2005.
Ghosal, Ashitava. Robotics: fundamental concepts and analysis. Oxford university press, 2006.

ME366N APPLIED MECHATRONICS IN MEDICINE AND REHABILITATION (3-0-0) 3

Foundation of medical mechatronics, Human Physiology Relevant to Mechatronics, Sensors and Signal Acquisition, Actuators in Biomedical Devices, Signal Processing and Filtering Techniques for Biomedical Applications, Embedded Systems and Microcontrollers for Medical Applications, Design and Development of Wearable Health Monitoring Devices, Rehabilitation Engineering – Exoskeletons and Assistive Devices, Medical Robotics – Surgical Robots, Haptics, and Control Mechanisms, IoT in Healthcare, Remote Patient Monitoring and Smart Health Systems, Safety Standards and Regulatory, Compliance in Medical Devices (FDA, ISO, IEC 60601), Case study 1, 2 and 3

Saimak Najarian et al., Mechatronics in Medicine A Biomedical Engineering Approach, McGraw Hill; 1st ed. 2011
John D. Enderle and Joseph D. Bronzino. Introduction to biomedical Engineering, Elsevier; 3rd Edition 2012

ME398N/ ME448N/ ME498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

ME399N MAJOR PROJECT - I (0-0-18) 9

The students jointly or individually will be assigned an experimental or a theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VI, VII & VIII semester. The students should complete the preliminary literature survey and a part of the work in the VII semester. Their work will be reviewed and evaluated.

ME449N MAJOR PROJECT - II (0-0-18) 9

ME499N MAJOR PROJECT - III (0-0-18) 9

ME401N MULTI-BODY DYNAMICS AND APPLICATIONS (2-1-0) 3

Kinematics of particles and rigid bodies, Euler angles, Generalized displacement, velocity and acceleration, Rigid body dynamics, D'Alembert's Principle, Virtual work application in dynamics and Lagrange's equation, Constraints formulation in Multi Body Systems, Formulation of joint constraints for various joints used in practice, Formulations of Constrained Dynamics Equations, Lagrange Multipliers, Multi Body Dynamics Solution, Numerical Integration, Computer simulation of the dynamic behaviour of multi-body systems using software tools, Treatment of holonomic and non-holonomic constraints through various elimination and augmentation methods, Application to Vehicle Dynamics, Engine Dynamics, Application to, Power Train Dynamics, Tyre models in Vehicle dynamics, Stability Analysis, Deformable Multi Body Dynamic Simulation.

Ahmed A. Shabana, "Dynamics of Multibody Systems", 3rd edition, Cambridge University Press, 2010.Ashok G.Ambedkar, Mechanism and Machine Theory Paperback, 2018
Michael Blundell and Damian Harty., "The Multibody Systems Approach to Vehicle Dynam-ics", Elsevier Limited, 2004

ME402N THEORY OF FATIGUE AND ANALYSIS (3-0-0) 3

Introduction to linear elastic fracture mechanics: Fracture terminology, Griffith energy balance, Energy release rate, Stress intensity factor, fracture toughness, crack growth resistance, Fatigue failure mechanism: Material Crystal Structure, Crack Initiation and Crack Growth, Fracture, Fatigue load: Constant amplitude loads, variable amplitude loads, types of fatigue testing machines generate fatigue loads, Fatigue design methods: Strategies in Fatigue Design, Fatigue Design Methodologies, Analysis and Testing, Probabilistic Design and Reliability, CAE and Digital Prototyping, In-service Inspection and Acquisition of Relevant Experience, High-cycle fatigue methods: Stress-Life (S-N) Curve, Fatigue Design Models, Low-cycle fatigue methods: Stress-Plastic Strain Power Law Relation, Low-cycle fatigue methods: Cyclic Hardening and Soft, Strain-based Approach to Total Life, Fatigue crack growth: Fatigue Crack Growth Rate, Fatigue Crack Growth Testing, Life Estimation, Fatigue crack growth: Fatigue Crack Growth Testing, Life Estimation, Notches and Their Effects: Types of Notches, Notch Sensitivity, Effects of Stress on Notch Factor, Construction of S-N curve, Cumulative design methods: Fatigue from variable amplitude loading, Cumulative Damage Theories, Cycle counting methods: Rainflow Cycle Counting Method, Cycle counting methods: Hysteresis Loop Counting Method, Case Studies.

Ralph I. Stephens, Ali Fatemi, Robert. R. Stephens and Henry O Fuchs, Metal Fatigue in engineering, 2nd Edition, John Wiley, New York, 2000.
Robert L. Norton, Machine Design - An Integrated Approach, 5th Edition, Pearson, 2018.

ME403N EXPERIMENTAL STRESS ANALYSIS (2-1-0) 3

Review of Elementary Elasticity, Review of Fracture Mechanics, Mechanical and electrical Strain gauges, Experiments related to strain gauges, Experiments related to strain indicator and gauges, Optical methods of stress analysis, 2-D Photoelasticity, Photoelasticity experiments-1, Photoelasticity experiments-2, Moiré and holography, Instrumentation and digital experimental data processing, Instrumentation and digital experimental analysis, Photoelastic coatings, Special Applications.

James W Dally and William F Riley, Experimental Stress Analysis, McGraw-Hill, 2000.
Srinath, Lingaiah, Raghavan, Experimental Stress Analysis, Tata McGraw-Hill, 1991.

ME404N SYNTHESIS OF MECHANISMS (2-1-0) 3

Introduction, tasks of Kinematics Synthesis, Type synthesis, Tools of dimensional synthesis, Graphical synthesis: Motion generation-two and three prescribed motions, Path generation - three positions without prescribed timing, Graphical synthesis: Path generation - three positions with prescribed timings, four positions without prescribed timings, Graphical synthesis: Function Generator - Three prescribed points, Introduction to Analytical synthesis, Standard Dyad form, Introduction to three prescribed positions for motion generation, path generation, Analytical synthesis: function generation: Freudenstein's equations for three-point function generation, Analytical synthesis circle, point and center-point circles, order synthesis, coupler curves for four-link, slider-crank and inverted slider-crank mechanisms, Application of coupler curves in design of six-link mechanism, Coupler cognate mechanisms, Errors in Kinematic Synthesis of Mechanisms, Structural synthesis of mechanisms: synthesize various kinematic chains/ mechanisms for a given number of links and degrees of freedom, Approximate synthesis: least square method

George N Sandor and Arthur G Erdman, Advanced mechanism design: analysis and synthe-sis, vol.2, Prentice Hall india, 1984
Ashok G.Ambedkar, Mechanism and Machine Theory Paperback, 2018

ME405N INTERNAL COMBUSTION ENGINES (2-1-0) 3

Engine Classification, Principle of operation of engines, Introduction to engine thermodynamics, Ideal cycles, Comparisons of Ideal Cycles, Combustion in Engines, Fuel-air cycles, Engine performance parameters

(Efficiencies etc.), Combustion in SI engines, Knocking, factors affecting knock, Types of SI engine combustion chambers, Combustion in CI engines, Knocking, factors affecting knock, Types of CI engine combustion chambers, Carburation, Injection systems, Heating and cooling of engines, Supercharging, Turbocharging

V.Ganesan, Internal Combustion Engines, McGraw-Hill, 1995.
Heywood John B., "Internal Combustion Engine Fundamentals", McGraw-Hill International Editions, Automotive Technology Series, 1989.

ME406N HYDROGEN GENERATION, STORAGE AND UTILISATION (2-1-0) 3

Hydrogen and Sustainability, Hydrogen Production Methods, Design of Hydrogen Generation Systems, Hydrogen Storage Systems, Codes and Standards, Performance and Efficiency, Safety and Regulations, Risk assessment and Mitigation Strategies, Utilization of Hydrogen in Fuel Cells, Combustion, Power, Heating and Cooling, Ammonia Synthesis, Synthetic Fuels, Case Studies.

Gupta, R. B., Hydrogen Fuel: Production, Transport, and Storage, CRC press, 2008.
Zhang, J. Z., Li, J., Li, Y., Zhao, Y., Hydrogen Generation, Storage and Utilization, John Wiley & Sons, 2014.

ME407N MICROFLUIDICS (2-1-0) 3

Introduction to microfluidics and applications, Scaling laws and effects in microfluidics, Transitional and free molecular regimes, Maxwell first order slip model and accommodation coefficients, Effects of compressibility, Analysis of thermo-fluidic transport in microscale gas flows and its applications, Low Re flows and examples, Liquid and particle handling and transport in microscale, Surface tension driven flows and microcapillary transport, Young Laplace equation and concept of contact angle, Dynamics of Capillary rise, Electrohydynamics- Introduction and brief review, Electrical double layer, Electroosmosis and applications, Electrophoresis, Dielectrophoresis and applications, Analysis of hydro-dynamically and thermally fully developed electro-osmotic flows, Ac electro-osmosis, electroosmotic flow of non-Newtonian fluids, Microfabrication techniques, Mixing in microfluidics, Biomicrofluidics.

Patrik Tabeling, Introduction to Microfluidics, Oxford University Press, 2011
H. Bruus, “Theoretical Microfluidics”, Oxford University Press Inc., 2008

ME408N THERMAL MANAGEMENT OF ELECTRONIC DEVICES (3-0-0) 3

Electronics Packaging, Contact and Spreading Resistances, Heat Sink Design Principles, Thermal Interface Materials, Phase Change Materials, Passive and Novel Air Cooling, Microchannels, Jet Impingement, Immersion Cooling, Heat Pipes, Vapor Chambers, Nucleate Pool Boiling of HighlyWetting Dielectric Liquids, Thermoelectric Cooling, Applications: Avionics, Data Centers, Mobile Devices, Internet Of Things (Iot), High-Performance Computing, Automotive Electronics, And Other Emerging Applications, Case studies

Lee, H., Thermal design: Heat sinks, thermoelectrics, heat pipes, compact heat exchangers, and solar cells (2nd ed.), Wiley, 2022.

ME409N SUSTAINABLE MANUFACTURING (3-0-0) 3

Introduction to Sustainability, Evolution and importance of sustainability in manufacturing, opportunities and challenges in sustainability, United Nations Sustainable Development Goal, Global trends, ISO standards, Triple bottom line approach, Sustainable manufacturing practices and tools: Quality function deployment, Lean manufacturing, Agile Manufacturing, Green manufacturing, Green materials, Circular Economy, Waste management, Resource recovery, Industry 4.0/5.0, Smart manufacturing, Sustainable design strategies, overview of environmental sustainability, economic sustainability, and social sustainability, Life cycle assessment (LCA): Overview of LCA, Qualitative and Quantitative methods of LCA, LCA stages and databases, Life cycle Goal and scope, Life cycle Inventory methods, impact assessment methods, Interpretation, Foot printing: Carbon, water and ecological, Decarbonization, Key performance indicators,

Sensitivity and uncertainty analysis, Economic sustainability: Assessment of economic sustainability, Life cycle costing, Economic Input-Output models, Types of costs, Social sustainability: Introduction to work management, Performance indicators, Modelling and assessing social sustainability. Case Study and Laboratory sessions on software/packages related to LCA: Case studies on Unit, product manufacturing processes.Sustainability framework development, Mass and energy balance, Data interpretation, Sustainable solutions, and documentation.

Dornfeld, D.A. ed., Green manufacturing: fundamentals and applications. Springer Science & Business Media, 2012.
Allen, D. T., and Shonnard, D. R., Sustainable Engineering: Concepts, Design & Case Studies, Pren-tice-Hall, 2012.

ME410N NON-DESTRUCTIVE EVALUATION (3-0-0) 3

Introduction to NDE: need, defect types, comparison with destructive testing, overview of major methods, Visual inspection and surface methods; defect characterization, acceptance criteria, case studies, Dye penetrant testing: principles, procedure, sensitivity, limitations, typical industrial uses, Magnetic particle testing: magnetization, indications, equipment, ferromagnetic materials, safety, Eddy current testing: EM principles, probes, frequency effects, tube and surface inspection, Ultrasonic testing I: wave types, equipment, calibration, pulse echo, straight beam, Ultrasonic testing II: angle beam, TOFD, phased arrays, defect sizing, examples, Radiography: X ray/gamma sources, detectors, Image quality, radiation safety, Acoustic emission testing: sources, sensors, localization, structural health monitoring, Active thermography and microwave methods: principles and selected applications, Optical and advanced NDE: stereography, DIC, hybrid techniques. NDE in quality control; codes, standards, Industrial case studies, course review.

C.G. Krishnadas Nair and J. Prasad, Non-Destructive Testing and Evaluation of Materials, 2nd ed., McGraw Hill Education.
Peter J. Shull (Ed.), Nondestructive Evaluation: Theory, Techniques and Applications, Marcel Dekker, NY, USA

ME411N PRODUCTION OPERATIONS MANAGEMENT (2-1-0) 3

Introduction to POM, Organization structures, Economic Analysis, Process Analysis, Work Study, Productivity, Value Analysis, Break Even Analysis, Layout and Location of Facilities, Line Balancing, Demand Forecasting, Inventory Control, Job sequencing, Material Requirement Planning, Aggregate Planning, Scheduling

Panneerselvam, “Production and Operations Management”, PHI Learning Pvt Ltd, 2006
Samuel Eilson, “Elements of Production Planning and Control”, Mc Milan Company, 1962.

ME412N POST-PROCESSING OF ADDITIVELY MANUFACTURED PARTS (3-0-0) 3

Introduction and Fundamentals: Categorization of AM, Working principle of various AM Process, Introduction and Fundamentals: Characteristics of AM components: microstructure, surface roughness, dimensional inaccuracy, Introduction and Fundamentals: Residual stress: causes, types, and consequences, Introduction to post-processing goals: mechanical, thermal, surface-based improvements, Residual Stress Mitigation: Heat treatment methods (annealing, stress relief, HIP), Influence of heating profiles and holding time, Shot peening, ultrasonic impact treatment, Residual Stress Mitigation: laser shock peening, and cryogenic treatment, X-ray diffraction, neutron diffraction, hole-drilling, FEM-based stress prediction, Case Studies & Applications: Residual stress management in aerospace, biomedical, and tooling components, Case Studies & Applications: Biomedical, and tooling components, Surface Quality Enhancement: Stair-stepping effect, powder adhesion, melt pool defects, CNC machining, grinding, polishing, and burnishing, Limitations due to complex geometries, Surface Quality Enhancement: Abrasive flow machining, electrochemical polishing, laser finishing, Surface chemistry modification, laser finishing, Surface chemistry modification, Surface Quality Enhancement: Surface profilometry, SEM, optical methods, Functional impact of roughness (e.g., fatigue, corrosion, wear), Integration

and Future Trends: Hybrid treatments, automated workflows, Post-processing for multi-material AM, Certification, Standards & Research Directions: ASTM/ISO standards for post-processing, Open research challenges and advanced process control, Demonstration and hands-on training on Metal Additive Manufacturing: Powder Feed Laser Directed Energy Deposition

D. Bourell, J. Beaman, M. Leu, and D. Rosen, Materials for Additive Manufacturing, 1st ed. Cham, Switzerland: Springer, 2017.
M. F. Zaeh and G. Branner, "Investigations on residual stresses and deformations in selective laser melting," Prod. Eng. Res. Devel., vol. 4, no. 1, pp. 35–45, Jan. 2010.

ME413N MODELLING AND SIMULATION OF MECHATRONICS SYSTEMS (3-0-0) 3

Basic component models-1, Basic component models-2, System model and automated computer simulation-1, System model and automated computer simulation-2, State space equation and analysis of linear systems-1, State space equation and analysis of linear systems-2, State space equation and analysis of linear systems-3, Transducers, amplifiers- modelling and instruments-1, Transducers, amplifiers- modelling and instruments-2, Mechanical and thermo fluidic systems-1, Mechanical and thermo fluidic systems-1, Nonlinear system simulation, Case study-1 and 2.

Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg, System Dynamics: Modelling and Simulation of Mechatronic Systems Wiley-Interscience, 5th edition ,2012.
Ernest O. Doebelin, System Dynamics: Modelling, Analysis, Simulation, Design Marcel Dekker 1998

ME414N ELECTRIC VEHICLE TECHNOLOGIES (3-0-0) 3

Introduction to Electric Vehicles (EVs), History and evolution, Types of electric vehicles (BEV, HEV, PHEV, FCEV), EV vs ICE vehicles: performance, efficiency, and environmental impact, Electric Motors, characteristics and selection criteria, Motor control methods, Battery Technologies, Battery fundamentals and types, Battery parameters, Battery charging and management systems (BMS), Power Electronics and Controllers, Inverters, converters, and their roles, Motor drives and controllers, Regenerative braking systems, Electric Vehicle Design and Integration, Chassis design, transmission in EVs, Packaging of batteries and drive systems, Thermal management, Charging Infrastructure, Charging standards, Vehicle Simulation and Modelling, Range estimation and drive cycle simulation, Environmental and Policy Aspects, Life cycle assessment of EVs, Government policies and incentives, Future trends in EVs and sustainability, Case study-1 and 2

Amir Khajepour, M. Saber Fallah, Avesta Goodarzi, "Electric and Hybrid Vehicles: Technolo-gies, Modelling and Control – A Mechatronic Approach" Wiley, 2014.
James Larminie and John Lowry "Electric Vehicle Technology Explained", Wiley, 2012

ME415N DYNAMICS AND CONTROL OF MECHANICAL SYSTEMS (3-0-0) 3

Introduction to rigid body kinematics: coordinate systems, position and orientation representation, rotation matrices and their properties, Euler angles and quaternions, Homogeneous transformation matrices and their properties, with illustrative examples, Linear and angular velocity of a rigid body, Skew-symmetric angular velocity matrix, Space-fixed and body-fixed angular velocity representations, Linear and angular acceleration, Joints in multi-body systems and joint variables, Degrees of freedom and constraints in joints and multi-body systems, Holonomic and non-holonomic constraints, Velocity and acceleration analysis of rigid bodies in multi-body systems, Mass and inertia properties of rigid bodies, Inertia matrix and its properties, External forces and moments acting on rigid bodies, including gravity, friction, and actuator forces/torques, Free-body diagrams, Newton–Euler formulation and derivation of equations of motion, Introduction to recursive formulations, Worked examples, Derivation of equations of motion using the Lagrangian formulation, Case studies: rolling of a thin disk in three dimensions, two-link robot, and four-bar mechanism, Solution of equations of motion using MATLAB, Modelling and simulation of multi-body systems using computer-based tools, Practical examples using Simscape, Linearization of nonlinear equations of motion, State-space formulation, definition

of state variables, and solution of state equations, System properties in SISO systems: stability, controllability, and observability, Classical control analysis tools: root locus and Bode plots, Relationship between classical control methods and state-space approaches, Controller design using state-space methods and root locus techniques, Case studies in modelling and control, including planar robots, pendulum on a cart, gyroscopic stabilization, and related applications, Case study-1 and 2.

A. Ghosal, Robotics: Fundamental Concepts and Analysis, OU Press, 2006J. L. Meriam, and L. G. Kraige, Engineering Mechanics: Dynamics, Wiley, 2013/7Edition

ME451N VEHICLE DYNAMICS (3-0-0) 3

INTRODUCTION TO VEHICLE DYNAMICS: - Automobile - working principles and construction details, Fundamentals approach of Vehicle Modelling, Dynamic axle loads, ACCELERATION PERFORMANCE: - Transmission system, Power limited acceleration, Traction limited acceleration, traction and tractive effort, distribution of effort, Stability of a vehicle on a slope, BRAKING PERFORMANCE: - Braking System, Braking forces, anti-lock braking system; wheel lock-up; tire/road friction, ROAD LOADS: - Aerodynamics, Vehicle drag, Rolling Resistance, Grade resistance, TIRE AND TIRE DYNAMICS: tire specifications and constructions, tire motion analysis, tire force analysis, tire contact stress analysis, tire vibration analysis, tire wear and maintenance, RIDE: riding comfort; perception of vibration, vibration sources, vibration transmission to the passengers, vibration models, vibration isolation techniques, STEADY-STATE CORNERING: lower speed cornering, high speed cornering, Suspension effects on cornering, Dynamics of a vehicle running on a banked and curved track, SUSPENSIONS: - Suspension Systems, Vehicle dynamics and suspension requirements, Solid Axles, Independent Suspensions, Active Suspensions, Semi -Active Suspensions, STEERING SYSTEM: Ackerman steering gear, Devis steering gear, steering gears, Power steering, Steering System Forces and Moments, Steering Geometry Error, Steering System Models, Influence of Front-Wheel Drive, VEHICLE VIBRATIONS: - SDOF system subjected to Base Excitations, Force transmissibility, Displacement transmissibility, Two DOF Systems, Pitch – Bounce model of a car, Concept of Vibration Absorbers, MDOF systems, VEHICLE MODELLING AND RESPONSE STUDIES: - Dynamic response studies using Quarter Car model, Half Car model, Full Car model in Time domain and Frequency domain, ELECTRIC AND HYBRID ELECTRIC VEHICLES:- Electric Vehicles:- Configuration and performance of Electric vehicles, Traction motor chacraterstics, Traction effort and transmission requirements, vehicle performance, Energy consumption, Hybrid Vehicles:- Concept of hybrid electric drive trains, Archteture of hybrid vehicles, Series and parallel hybrid electric vehicles, OFF-ROAD VEHICLE DYNAMICS: - Stability, Ride Comfort, Vehicle Performance and Modelling, RAIL VEHICLE DYNAMICS: - Rail vehicle dynamics and interaction between vehicle and track, Rail vehicle mathematical models, Ride comfort Analysis, Stability Analysis

T.D. Gillespie, "Fundamentals of vehicle dynamics", Society of Automotive Engineers, War-rendale, PA, 1992. WICKENS A., FUNDAMENTALS OF RAIL VEHICLE DYNAMICS: Guidance and Stability, TAYLOR & FRANCIS; 1st edition, 2003.

ME452N CONDITION MONITORING (3-0-0) 3

INTRODUCTION TO CONDITION MONITORING: - Need for Machinery condition Monitoring, Fault diagnosis and prognosis, Principle of Maintenance, Bath tub curve, Failure modes and effects analysis (FMEA), OVERVIEW OF MECHANICAL VIBRATION: - SDOF subjected to base excitation, Force transmissibility, Displacement transmissibility, Whirling of shafts, MDOF systems, VIBRATION MEASUREMENT AND APPLICATIONS: -, Vibration Measuring Instruments, Vibration Severity and Standards, Machinery Vibration Standards, EXPERIMENTAL MODAL ANALYSIS: - Need for experimental modal analysis, Hammer roving method, Shaker Method, Frequency Response Function (FRF), Bode Plots, Nyquist plot, VIBRATION MONITORING: - Fault Signatures, Typical Spectra and phase relationships for some common machinery faults, Case studies, SIGNAL PROCESSING: - Time domain analysis, Fourier transforms, FFT, Cepstrum techniques, EMD technique, WAVELET TRANSFORM: - Demerits of time and Spectrum analysis, STFT, Continuous and discrete wavelet transforms, ONLINE CONDITION MONITORING TECHNIQUES: - Fault

diagnosis using machine learning approach - Procedure, decision tree technique, information entropy, ANN, SVM and Bayes classifier usage in fault classification, ROTOR DYNAMICS: - Single rigid rotor disc system, Unbalance response and critical speed, Journal bearings, Oil whirl and oil whip, Condition monitoring in large rotors, NOISE MONITORING: - Noise sources, Sound fields, Near and far field, Anechoic chamber, Reverberation chamber, Noise measurement, Noise source identification, ELECTRICAL MACHINERY FAULTS: - Faults in electrical motor, Motor current signature analysis (MCSA), MCSA for fault detection in electrical motors, OIL AND WEAR DEBRIS ANALYSIS: - Detection of wear particles, Spectroscopy, Ferrography, Particle count, Oil analysis, NON-DESTRUCTIVE TESTING: - Thermography, Eddy current testing, Ultrasonic testing, Acoustic Emission, radiography, liquid penetrant testing, etc. CASE STUDIES

Amiya R. Mohanty, Machinery condition monitoring, CRC Press, 2015.
R. A. Collacott, Vibration monitoring and diagnosis, George Godwin Ltd London, 1979.

ME453N INJURY BIOMECHANICS (3-0-0) 3

Introduction to injury biomechanics; epidemiology of road traffic and sports injuries; scope and ethical considerations, Fundamentals of experimental biomechanics; cadaver, dummy, and volunteer studies; instrumentation and limitations, Crash and impact mechanics; energy transfer, ride-down concept, pulse shaping; examples from vehicle and sports impacts, Injury criteria and metrics: AIS, MAIS, ISS, IARVs; interpretation and real-world relevance, Head and brain injuries: concussion biomechanics, HIC, rotational injury; helmet design principles, Spine and spinal cord injuries; whiplash, neck injury criteria (NIC, Nij); prevention strategies, Thorax and abdominal injuries; injury mechanisms, tolerance limits, restraint and padding technologies, Pelvis and lower extremity injuries; femur force, tibia index; vehicle and sports injury countermeasures, Injury mitigation technologies: airbags, seatbelts, helmets, body armor; effectiveness evaluation using case studies, Public injury databases: NHTSA, NCAP, CIREN; hands-on exploration of crash and injury datasets, Sports injury databases: NFL, FIFA, Olympic studies, Sports injury databases: comparison with road traffic injury mechanisms, Group project presentations: safety gear or injury mitigation design; Group project presentations: real-world case analysis and critical discussion.

Kai-Uwe Schmitt, Peter F. Niederer, Duane S. Cronin, Markus H. Muser, Felix Walz, Trauma biomechanics: An introduction to Injury Biomechanics, 5th Edition, Springer, 2014.
Duane Knudson, Fundamentals of biomechanics, 2nd Edition, Springer, 2007

ME454N MECHANICAL VIBRATION AND ACOUSTICS (3-0-0) 3

Mechanical Vibration: Introduction, and Review of Single DOF System, Modelling of Discrete Systems, Multi d.o.f. systems, Derivation of governing differential equation, Normal mode analysis, Eigen value problem, Natural frequencies and mode shapes, Free vibration, Transient, and Steady state response of Multi-DOF systems, Continuous Systems: Axial Bar, Tosional System, and Beam, Natural Frequencies and Mode shapes for different boundary conditions, Introduction to Experimental Modal Analysis, Vibration Control, Introduction to Vibration Control, Acoustics: Introduction, Acoustics Terminology, Effects of noise on human, Plane wave equation: sound transmission and absorption co-efficients with and without physical separation, Room Acoustics, Noise control techniques, Sound Measurement techniques, Measurement through impedance tube, Micro-Perforated Panels and Meta Materials for sound abosorption, Case Studies.

Singiresu S. Rao, Mechanical Vibrations, 6th Edition, Pearson, 2017.
C. Sujatha, Vibration and Acoustics, Measurement and Signal Processing, McGraw Hill Education, 2017.

ME455N REFRIGERATION & AIR CONDITIONING (2-1-0) 3

Fundamental concepts of Refrigeration systems, Refrigerants and its properties, Refrigeration Cycles, Air Cycle Refrigeration, Vapour Compression System, Multi-pressure System, Cascade Refrigeration, Vapour Absorption System, use of low grade energy in refrigeration, Ejector Refrigeration System, Desiccant Cooling System, Psychrometry, Air-conditioning processes, use of Psychrometric chart, Cooling load calculations,

Types of air conditioning systems, Winter air conditioning, Summer air conditioning, Applications of air conditioning, Heat Transfer through Building, Duct System

Refrigeration and Air conditioning, C.P. Arora, TATA McGraw Hill.

ME456N COMPRESSIBLE FLOWS (2-1-0) 3

Recapitulation of fundamentals, Propagation of Small Disturbances in Gases, Velocity of Sound and Mach Number, Normal and Oblique Shock Relations, Nozzle Flows, One-Dimensional Unsteady Flow, Small Disturbance Theory of Supersonic Speeds, Supersonic Flow Over Two-Dimensional Bodies, Shock Expansion Analysis, Method of Characteristics, Aspects in rockets, spacecraft, and aircraft design, Medical applications of shock waves, Introduction to computational methods for compressible flows, Applications of AI/ML: deep learning, Reduced-order and physics-informed models, Design optimization

Liepmann, H. W., Roshko, A., Elements of Gasdynamics, United States: Dover Publica-tions, Incorporated, 2013.
Anderson, J. D., Modern Compressible Flow: With Historical Perspective,4th ed., United Kingdom: McGraw-Hill, 2021.

ME457N GAS TURBINE AND JET PROPULSION (2-1-0) 3

Introduction to Aircraft Propulsion, Classification of Engines, Basic Thrust Concepts, Propulsive Efficiency, Thermodynamics of Gas Turbine Engines, Ideal Brayton Cycle Analysis, Real Brayton Cycle, Losses, Component Efficiencies, Simple Turbojet Engine: Working Principle and Performance Analysis, Turbofan Engines: Bypass Ratio, Thrust and Efficiency, Turboprop and Turboshaft Engines: Applications and Performance, Ramjet and Scramjet Engines: High-Speed Propulsion Concepts, Axial Flow and Centrifugal Compressors: Working and Characteristics, Compressors for Gas Turbines: Axial and Centrifugal, Performance Characteristics, Combustion Chambers: Types, Combustion Efficiency, Emissions, Turbines for Gas Turbines: Axial Turbines, Cooling, Materials. Thrust Augmentation, Afterburning, Variable Geometry Nozzles. Miniproject presentation/discussion

Saravanamuttoo, H. I., Rogers, G. F. C., & Cohen, H., Gas turbine theory. Pearson Education, 2001.
Hall, C., & Dixon, S. L., Fluid mechanics and thermodynamics of turbomachinery. Butterworth-Heinemann, 2013.

ME458N PRINCIPLES OF TURBOMACHINERY (2-1-0) 3

Introduction to Turbomachinery, Classification, Applications, Energy Transfer Concepts, Fluid Kinematics in Turbomachines, Velocity Components, Velocity Triangles, Euler's Turbomachinery Equation, Degree of Reaction, Work Transfer, Losses in Turbomachinery, Efficiencies, Performance Parameters, Similarity Laws, Dimensional Analysis, Specific Speed and Scaling, Centrifugal Pumps: Construction, Working Principle, Performance Curves, Axial and Radial Flow Pumps, Cavitation, NPSH, Axial Flow and Centrifugal Compressors: Working and Characteristics, Compressors: Surge, Choking, Stall, Performance Maps, Steam and Gas Turbines: Impulse and Reaction Turbines, Turbine Losses, Stage Efficiency, Performance Characteristics, CFD in Turbomachinery Design, Turbomachinery in Sustainable Energy, Miniproject Evaluation/Discussion.

S.M. Yahya, Turbomachines, Mc Graw Hill, 2026
Maneesh Dubey, BVSSS Prasad, Archana Neema, Turbomachinery, Mc Graw Hill, 2026

ME459N ENGINEERING TRIBOLOGY (3-0-0) 3

Explore surface topography, roughness parameters, and the fundamental nature of contact between engineering surfaces, Analyze Hertzian contact mechanics and deformation theories for spherical and cylindrical mechanical interfaces, Study classical friction laws and advanced adhesion and plowing theories to

understand energy loss mechanisms, Categorize wear modes including abrasive, adhesive, and fatigue wear while applying Archard's wear equations, Evaluate the Stribeck curve to distinguish between boundary, mixed, and hydrodynamic lubrication regimes, Examine lubricant properties, viscosity index, and the chemical role of extreme pressure and anti-wear additives, Design and evaluate industrial bearings and tribological systems using Reynolds equation, Fluid film thickness calculations, Design and analyze hydrodynamic journal and thrust bearings for industrial rotating machinery applications, Apply surface engineering treatments and thin-film coatings to enhance hardness and reduce frictional wear, Implement condition monitoring and oil debris analysis techniques for predictive maintenance and reliability, Utilize machine learning research tools and neural networks for predictive maintenance, Real-time wear pattern recognition, Explore advanced frontiers in Nanotribology, Biotribology, and Space tribology to address challenges in extreme and biological environments

John Williams, Engineering Tribology, 4th Edition, Cambridge Univ. press, 2012.
Bharat Bhushan, Modern Tribology Handbook, 2nd Edition, CRC Press,2013.

ME460N SURFACE MODIFICATION AND CHARACTERIZATION (3-0-0) 3

Physical Vapor Deposition: Thermal evaporation, Sputter deposition, Ion plating, Chemical Vapor deposition: System and reactions, Plasma enhanced CVD, Laser enhanced CVD, Thermal spray Coatings: Flame Spray, Cold Spray, Plasma spray, Detonation gun and High velocity oxy-fuel process, Post coating treatment, Electro and Electroless Plating Processes, Carburizing, Nitriding, High-energy Surface Modifications-Electron beam hardening, Laser hardening, Ion implantation, Characterization and Testing of Coatings-Scanning Electron Microscope, Transmission Electron Microscope, X-ray Diffraction, Film thickness measurements, coating adhesion, Residual stresses, Nano-indentation, Surface degradation: Friction and wear, corrosion, fatigue

M. Ohring, The Materials Science of Thin Films, 3rd edition, Academic Press Inc, 2010
Rointan F. Bunshah, Handbook of Hard Coatings, 1st edition, Noyes Publications, 2001

ME461N AI IN MANUFACTURING (3-0-0) 3

Introduction to Artificial Intelligence, machine learning concepts, types of AI systems, and relevance to modern manufacturing, Overview of Industry 4.0, smart manufacturing architecture, cyber-physical systems, and role of AI in intelligent factories, Fundamentals of supervised and unsupervised learning techniques with examples from manufacturing data, Classification algorithms for fault detection, quality classification, and decision-making in manufacturing processes, Regression techniques for process Modelling, performance prediction, Parameter optimization in manufacturing systems, Clustering methods, feature extraction, and dimensionality reduction for large-scale manufacturing datasets, Model training, validation, performance metrics, overfitting, and deployment challenges in industrial AI applications, Predictive maintenance concepts using machine learning, sensor data analytics, and failure prediction strategies, AI-based process monitoring, anomaly detection, and optimization techniques for manufacturing operations, Computer vision techniques for visual inspection, defect detection, and automated quality control systems, Applications of AI in supply chain management, production planning, scheduling, and logistics optimization, Ethical, cybersecurity, and safety considerations in AI systems, Introduction to generative AI and digital twins

Kim Phuc Tran, Artificial Intelligence for Smart Manufacturing: Methods, Applications, and Challenges, Springer Nature, 2023.
P.K. Wright and David A. Bourne, Manufacturing Intelligence, 1st Edition, Addison-Wesley Educational Publishers Inc., 1988.

ME462N BIO MANUFACTURING (2-1-0) 3

Biomaterials - Analysis and design of Materials used in contact with biological systems, Biomaterials - strategies to develop new materials, essential properties of biomaterials, Bio-polymers, Introduction to Biomimicry, Case studies of biomimicry, Significance of Biomimicry: Importance and Benefits, Process for Biomimicry, Natural inventions: Extraction of the strategies of nature and implementation of those strategies,

Principles of nature’s design, Essential principles of sustainable design, Types of biomimetic design, Term project to get a hands-on exercise to use the learning, Introduction to Bio-MEMS, exploring the concept of self-assembly, Bio-MEMS application in product development.

Joon Park and R.S. Lakes - Biomaterials: An introduction. 3rd edition, Springer, 2007
Benyus, J.M., Biomimicry: Innovation inspired by nature. Reissue Edition, Harper Collins, 2002

Department of Mining Engineering (MN)
Bachelor of Technology in Mining Engineering

Basic Science Courses (BSC)

MA105N	Probability and Statistics	(3-0-0)3
MA107N	Multivariable Calculus	(3-0-0)3
PH100N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

CS101N	Computer Programming (Python)	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
UC101N	Introduction to Engineering	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

Programme Core Courses (PCC)

CE207N	Mining Geology	(2-0-0)2
CE257N	Mining Geology Lab	(0-0-2)1
MN200N	Mine Surveying	(1-1-2)3
MN201N	Underground Coal Mining	(2-1-0)3
MN202N	Drilling and Blasting Engineering	(2-1-0)3
MN203N	Surface Mining Technology	(2-1-0)3
MN204N	Mining Machinery	(2-1-0)3
MN250N	Mine Environment and Ventilation Engineering.	(1-1-2)3
MN251N	Rock Mechanics	(1-1-2)3
MN252N	Underground Metal Mining	(2-1-0)3
MN253N	Mine Planning and Design	(1-1-2)3
MN254N	AI/ML/IoT Application in Mining	(1-1-2)3
MN255N	Mine Evaluation	(2-1-0)3
MN300N	Mine Systems Engineering	(2-1-0)3
MN301N	Mine Hazards, Rescue and Recovery	(2-1-0)3
MN302N	Mineral Processing Technology	(2-0-2)3
MN303N	Health and Safety Engineering	(1-1-2)3
MN304N	Mine Legislation and Management	(3-0-0)3

Dept/Institute Elective Courses (DEC)

MN350N	Applied Mine Surveying	(3-0-0)3
MN351N	Noise Pollution and Control	(3-0-0)3
MN352N	Production Drilling for Oil Wells	(3-0-0)3
MN353N	Strata Mechanics	(3-0-0)3
MN354N	Advanced Surface Mining Technology	(3-0-0)3
MN355N	Mechanization and Materials Handling	(3-0-0)3
MN400N	Rock Fragmentation Engineering	(2-1-0)3
MN401N	Data Analytics in Engineering	(2-0-2)3
MN402N	Reliability Engineering	(2-1-0)3
MN403N	Rock Excavation Engineering	(3-0-0)3
MN404N	Tunneling and Underground Space Engineering	(3-0-0)3
MN405N	Application of Geoinformatics in Mining	(3-0-0)3
MN406N	Rock Slope Engineering	(3-0-0)3
MN450N	Industrial Engineering and Management	(3-0-0)3
MN451N	Coal Beneficiation	(3-0-0)3
MN452N	Mine Power System	(3-0-0)3
MN453N	Geostatistics	(3-0-0)3
MN454N	Instrumentation, Communication, and Automation	(2-1-0)3
MN455N	Mine Contract Management and Clearances	(3-0-0)3

Internships/Major Project Courses (IPC)

MN398N	Internship I	(0-0-18)9
MN448N	Internship II	(0-0-18)9
MN498N	Internship III	(0-0-18)9
MN399N	Major Project I	(0-0-18)9
MN449N	Major Project II	(0-0-18)9
MN499N	Major Project III	(0-0-18)9

Honors Courses

Students seeking an Honors degree shall earn a minimum of 15 additional credits from Postgraduate courses offered by the respective Department, as decided by the DUGC.

Suggested Plan of Study for B.Tech. in Mining Engineering:

Sem	I	II	III	IV	V	VI	VII	VIII
1	PH100N	CY100N	CE207N	CE257N	MN300N	MN398N/ MN399N	MN448N/ MN449N	MN498N/ MN499N
2	MA107N	MA105N	MN200N	MN250N	MN301N	Elective	Elective	Elective
3	CS101N	UC100N	MN201N	MN251N	MN302N	Elective	Elective	Elective
4	UC101N	DE100N	MN202N	MN252N	MN303N	Elective		
5	UC102N	UC103N	MN203N	MN253N	MN304N			
6			MN204N	MN254N				
7				MN255N				
8	PL1XWN/ PL1X9N	PL1YWN/ PL1Y9N	PL2XWN/ PL2X9N	PL2YWN/ PL2Y9N	PL3XWN/ PL3X9N			

Requirements for B.Tech. in Mining Engineering:

Category of Courses	Minimum Credits to be Earned
Basic Science Courses (BSC)	20
General Engineering Courses (GEC)	12
Life Skill Courses (LSC)	20
Programme Core Courses (PCC)	51
Dept/Institute Elective Courses (DEC) Optional: MOOC Courses (0 – 8 credits)	21
Internships/Major Project Courses (IPC)	27
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

MN200N MINE SURVEYING (1-1-2) 3

Principles of Mine Surveying, Plain Scale, Vernier Scale, Sources of Error in surveying, Problem Solving. Classification, Plane and Geodetic surveying; Measurement of Length by tape, Tape Corrections, Precise Linear Measurements. Compass Surveying: Prismatic Compass and Surveyor's Compass. Calculation of angles from bearings; Errors in compass surveying, Problem Solving. Leveling: Definitions; Methods of leveling; Booking field data. Errors in leveling; problems Solving. Contouring: Contour interval; Characteristics of contours; methods of contouring; interpolation of contours; uses of contour maps. Theodolites: Construction and operation; tests and adjustments; angle measurements; errors and mistakes; problems. Theodolite Traverse: Marking of stations; signals; linear measurement; angular measurement. Methods of traversing; balancing of traverse; misclosure. Computation of coordinates and plotting; checks and errors; adjustments; problems. Computation of Areas and Volumes; Dip, Fault and Borehole Problems.

Punmia, B. C. (2005). Surveying Vol. I & II; Kanerkar. Survcying. Vol - I ≪ Ghatak, S. (nd). Mine surveying and levelling (Vols. 1–3).

MN201N UNDERGROUND COAL MINING (2-1-0) 3

Status and scope of underground coal mining in India; importance and challenges. Classification of coal reserves: proved, indicated, inferred; estimation of commercial reserves and annual output. Opening of coal deposits; inclines, vertical shafts, and adits; comparison of opening methods. Shaft sinking methods and applications; advantages and limitations of different modes of opening. Basic coal mining methods; classification and factors influencing choice of mining method. Bord and pillar mining: concept, layout, panel development, and mechanized and semi-mechanized development techniques. Panel design: size of pillars, headings, and districts; panel development from main dip. Equipment used in development: chain conveyor, SDL, LHD, GAL, shuttle car, continuous miner. Room and pillar mining and operational considerations. Depillaring methods: caving and stowing techniques; extraction of pillars. And case studies of depillaring practices in Indian coal mines. Longwall mining: factors affecting longwall operations; face layouts and supports. Thick seam mining methods: sublevel caving, slice mining, shield method and roof support systems.

Deshmukh, D. J. (2009). Elements of Mining Technology, Vol. 1 (8th ed.); Singh, R. D. (2022). Principles and Practices of Modern Coal Mining (2nd ed.); Singh, T. N. (1992). Underground Mining of Coal. Hartman, H. L. (Ed.). (1992); Introductory Mining Engineering (2nd ed.). Wiley. Hartman, H. L., & Mutmansky, J. M. (Eds.). (2007); SME Mining Engineering Handbook (3rd ed.); Singh, J. G. (2000). Coal Mining. Lovely Prakashan.

MN202N DRILLING AND BLASTING ENGINEERING (2-1-0) 3

Applications of drilling in mining, classification of drilling methods, Mechanisms of rock drilling, Factors influencing percussive and rotary drilling. Different types of drill machines, Alignment and deviation of boreholes, Drilling for exploration, production drilling and drill patterns, Developments in explosives, including the classification and properties of explosives, Developments in initiating devices, Storage and handling of explosives, Exploders, circuit testers, safety aspects in blasting, Blast Design, Blasting layouts.

Das, S. K. (1993). Explosives and blasting practices in mines (1st ed.). Lovely Prakashan; Pradhan, G. K. (2020). Explosives & blasting technotes. Lovely Prakashan, Bhandari, S. (1997); Engineering rock blasting operations. A.A. Balkema

MN203N SURFACE MINING TECHNOLOGY (2-1-0) 3

Dimensions of open pits, Techniques for determining final pit limits, Production drilling and drill machines, Characteristics of explosives, Surface blast design and recent trends in blasting, Constructional and operational features of excavation and loading equipment's, Constructional and operational details of transporting equipment's, Layouts in open pit mines and Methods of opencast mining. Layout of waste dumps,

Conventional and continuous mining systems, Environmental management and reclamation planning, Techno-economic evaluation of surface mining projects, DGMS Regulations pertaining to surface mines, Case studies.

Das, S. K. (1984). Surface Mining Technology. Lovely Prakashan; Misra, G. B. (1994) Surface Mining. Dhanbad Publishers; Deshmukh, D. J. (1988), Elements of Mining Technology (Vols. 1–3). Central Techno Publishers; Hustrulid, W., & Kuchta, M. (2006), Open Pit Mine Planning and Design, Vol. 1: Fundamentals. Taylor & Francis. Martin, J. W. (1982), Surface Mining Equipment. Martin Consultants.

MN204N MINING MACHINERY (2-1-0) 3

Basic Principles of Transport: Transport of men, material, and minerals in underground mines, Techno-economic indices of transport systems, motive power used in mines, Pit-Top and Pit-Bottom layout, Wire Ropes: Construction; classification; applications, Wire Ropes. Inspection; capping and slicing of ropes, maintenance; calculation; testing; and relevant statutes, Rope Haulage: Types, principles of operation, suitability, Safety appliances, Rope Haulage: Signal systems for Rope Haulge, Rope Haulge Calculations, Winding: winding system components, Drum winding and Koepe winding; suspension gear for drum and Koepe winding, Winding: safety devices; mechanical and electrical braking system; safety features, Conveyor Transport: Purpose; types of conveyors; principle of operation, Conveyor Transport: description; applications and problem solving, Mine Pumps: Purpose; types of pumps; Drainage Pumping and Sumps Problem Solving.

Principles of Mining Machinery and Systems, by Dr M.K Mallick and Dr R Hasim, Khwaab Publication, 2025; Ramlu, M. A. (n.d.). Mine hoisting. Oxford & IBH; Walker, S. C. (1988). Mine winding and transport. Elsevier; Kerlin, T. W. (n.d.) Mine Transport; Hartman, H. L., and Mutmansky, J. M. (Eds.). (2007). SME Mining Engineering Handbook (3rd ed.). Society for Mining, Metallurgy, and Exploration (SME); Ghatak, S. (2007). Mine Hoisting. Lovely Prakash.

MN250N MINE ENVIRONMENT AND VENTILATION ENGINEERING (1-1-2) 3

Composition of mine atmosphere; major and minor gases in underground mines, Mine gases: production, properties, physiological effects, and detection methods, Methane occurrence in coal seams; methane emission sources and methane layering, Mine fires, fumes and harmful gases; monitoring and control measures, Sources of heat in mines; effects of heat and humidity on workers, Psychrometry; measurement of humidity and thermal conditions in underground mines, Airflow through mine openings; resistance of mine airways and Atkinson’s equation, Equivalent orifice concept; splitting of air current and ventilation standards, Natural ventilation: causes, seasonal variation, and calculation of natural ventilation pressure (NVP), Mechanical ventilation; types of mine fans and theory of centrifugal and axial fans, Fan characteristics, operating curves, fan laws, and selection of suitable mine fans. Forcing and exhaust ventilation systems; auxiliary ventilation in headings and development workings, Ventilation planning and layouts for underground coal mines. Ventilation surveys, measurement techniques, and interpretation of ventilation data.

Hartman, H. L. (1982). Mine Ventilation and Air Conditioning. John Wiley & Sons; Mishra, G. B. (1986). Mine Environment and Ventilation. Oxford University Press; Vardhan, H. An Introduction to Underground Mine Environment and Ventilation. NPTEL; Vutukuri, V. S., & Lama, R. D. (1986). Environmental Engineering in Mines. Cambridge University Press.

MN251N ROCK MECHANICS (1-1-2) 3

Definition, Applications of Rock Mechanics. Evolution of ISRMRE, Physical properties of rocks, Mechanics properties of rocks, Elastic constants under static and dynamic loading, Prediction of rock properties, Introduction to RsData software, Analysis of stresses and strains, Mohr’s representation of stress & strains and strain relationships, Stress distribution around circular and different shaped openings, Theories of failure, Objectives and rock mass classifications, Prediction of Subsidence, Prevention of subsidence, subsidence survey.

Goodman, R. E. (1989). Introduction to rock mechanics (2nd ed.). Wiley; Obert, L. and Duvall, W. I. (1967). Rock mechanics and the design of structures in rock. Wiley; Peng, S. S. (1978). Coal mine ground control. Wiley; Deb, D. and Verma, A. K. (2025). Fundamentals and applications of rock mechanics (2nd ed.). PHI Learning Pvt. Ltd; Vutukuri, V. S. and Lama, R. D. (1974–1978). Handbook on mechanical properties of rocks (Vols. 1–4). Trans Tech Publications.

MN252N UNDERGROUND METAL MINING (2-1-0) 3

Introduction to underground metal mining; characteristics of metalliferous ore deposits, Development and opening of ore deposits; selection of main entries, Planning dimensions of underground metal mines; determination of level interval and mine life, Stope production services: drawpoints, ore passes, chutes, and loading arrangements, Classification of stoping methods: supported, unsupported, and caving techniques. Supported stoping methods and applications in metal mines. Unsupported stoping methods and operational considerations, Caving methods and introduction to block and sublevel caving, Backfilling operations; materials, techniques, and paste filling methods, Cavability index and Laubscher cavability classification system, Stope design using Mathews stability graph approach and stability zones, Selection of mining methods based on geo-mining conditions and deep mining challenges, Solution mining and in-situ leaching methods for mineral extraction, Techno-economics of metal mining projects; case studies of open-pit to underground conversion.

Hartman, H. L. (1987). Introductory Mining Engineering. John Wiley & Sons; Hustrulid, W. A. (1985). SME Handbook on Metalliferous Mining. SME; NIOSH–Snowden (2016). Geological and Mining Reports of Underground Metal Mining, Vol. 2, Selected research articles from journals and conference proceedings related to course topics.

MN253N MINE PLANNING AND DESIGN (1-1-2) 3

Exploration, resource, and reserve estimation, UNFC classification of mineral resources and ore reserves estimation, Different Mine Planning Stages: Micro and macro planning, Pre-feasibility and Feasibility Study: Function and preparation; DPR for metallic minerals and non-metallic minerals, Design for Mining the Mineral Deposits by Open-pit Mining: Determination of size of mine, life of mine, and production rates, Design for Mining the Mineral Deposits by Open-pit Mining: the ultimate open pit profile based on physical and economical parameters; optimum pit design, Design for Mining Mineral Deposits by Underground coal Mining: Determination of size of mine, life of mine, design of pillar and stope, and production rates, Mine Environment and Reclamation: Purpose, concepts, standards, plans, methods, Production planning and scheduling; categorization of mines, Introduction to mineral block auctioning; contracting, Mine-Develop-Operate (MDO) concept; land acquisition and liaisoning for mining project.

Bhattacharya, J. (n.d.). Principles of mine planning. Allied Publishers; Cummins, A. B. and Givens, I. A. (n.d.). SME handbook. Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers; Hustrulid, W. A. (n.d.). Underground mining methods handbook. Society for Mining, Metallurgy, and Exploration; Hustrulid, W. A. and Kuchta, M. (n.d.). Open pit mine planning and design (Vol. 1). A. A. Balkema, Deshmukh, D. J. (n.d.). Elements of mining technology (Vol. 3). Central Techno Publications.

MN254N AI/ML/IOT APPLICATION IN MINING (1-1-2) 3

Overview of Artificial Intelligence (AI), Machine Learning (ML), and Internet of Things (IoT): Basic concepts and terminologies in AI and ML; B supervised, unsupervised, and reinforcement learning techniques; Overview of Artificial Intelligence (AI), Machine Learning (ML), and Internet of Things (IoT): introduction to neural networks and other prediction models, IoT Architecture and Components Relevant to Mining: Different types of sensors and communication systems like ZigBee, LoRa, IoT-Based Monitoring in Mining: Monitoring of environmental conditions, human body fatigue, equipment health, and ground movement using IoT sensors, IoT Data Acquisition and Real-Time Control: Data acquisition, transmission, processing, and real-time monitoring and control of mining operations through IoT systems, Role of AI, ML, and IoT in Smart Mining:

Significance, applications, and impact of AI, ML, and IoT technologies in enhancing safety, productivity, and operational efficiency in modern mining, Concept of AIoT in Mining: Fundamentals of Artificial Intelligence of Things (AIoT) and its relevance to smart and digital mining. AIoT for Intelligent Mining Systems: Designing intelligent systems for autonomous decision-making, process automation, and operational optimization in mining, Integration of AI/ML with IoT: Challenges, limitations, and solutions for integrating AI/ML models with IoT infrastructure in mining applications, Case Studies: Highlighting successful implementations in the mining industry; utilizing AI/ML/IoT for hazard detection and accident prevention; Case Studies on Smart Mine Monitoring: Underground environmental monitoring, worker health and safety monitoring using wearable IoT devices, and intelligent monitoring of mining operations, Case Studies on Intelligent Safety Systems: Slope stability monitoring, blast vibration monitoring, and AI/ML/IoT-enabled emergency response and disaster management systems, Mine Digitization: Concept, need, and scope of digital transformation in mining.

Russell, S. and Norvig, P. (2022). Artificial intelligence: A modern approach (4th ed.), Pearson Education; Müller, A. C. and Guido, S. (2016). Introduction to machine learning with Python. Shroff/O'Reilly; Bahga, A. and Madisetti, V. (2015). Internet of things: A hands-on approach. Orient Blackswan Private Limited; Chaulya, S. K. and Prasad, G. M. (2016). Sensing and Monitoring Technologies for Mines and Hazardous Areas. Elsevier; Deshmukh, D. J. (n.d.). Elements of mining technology (Vol. 3). Central Techno Publications.

MN255N MINE EVALUATION (2-1-0) 3

Introduction to mineral resources, resource classification, and National Mineral Policy, National mineral policies, sustainable development, and strategies for mining industry growth, Resource conservation principles and sustainable utilization of mineral resources, Mineral taxation, royalties, subsidies, and import-export regulations, Mineral trade, commodity markets, and derivatives in mineral trading, Mineral pricing mechanisms and factors influencing mineral prices, Sampling methods and techniques for mineral reserve estimation, Reserve estimation methods and economic block model concepts, Introduction to mine evaluation and stages of mining projects, Mining project evaluation using economic and financial analysis techniques. Economic evaluation techniques: NPV, IRR, Payback Period, Benefit-Cost Ratio, Determination of optimum mine size and production planning, Risk analysis and investment decision-making in mining projects.

Annels, A.E., Mineral Deposit Evaluation: A Practical Approach, Chapman Hall, 1991. Deshmukh; R.T., Mine and Mineral Economics, Emdee Publishers, 1986; Edwards, A. C., Mineral Resource and Ore Reserve Estimation, Australasian Institute of Mining and Metallurgy, 2001.

MN300N MINE SYSTEMS ENGINEERING (2-1-0) 3

Introduction to systems concept, analysis and systems engineering, Models in system analysis, Linear programming, graphical and simplex methods for solving linear programs, Sensitivity analysis in linear programming, Primal and dual linear programs, Integer programming algorithms, Network techniques for mining projects, CPM and PERT techniques and Transportation and assignment models, Dynamic programming, Deterministic and stochastic decision theory, Inventory control models and Queuing theory, Simulation techniques for equipment selection and production scheduling, Significance of management information systems in controlling and managing the mining activities.

Taha, H.A., Operations Research: An Introduction, 10th Edition, Pearson, 2017; Srinivasan, G., Operations Research: Principles and Applications, PHI Learning, 3rd Edition, 2017; Hillier, F.S. and Lieberman, G.J., Introduction to Operations Research, 11th Edition, McGraw Hill, 2020; Cummins, A.B., Mining Engineers Handbook, Vol. II, SME, AIME, New York, 1973.

MN301N MINE HAZARDS, RESCUE, AND RECOVERY (2-1-0) 3

Introduction to mine hazards; classification of mine disasters and safety principles, Mine fires: causes, classification, and characteristics of underground fires, Spontaneous combustion of coal; mechanism and stages of spontaneous heating. Factors influencing spontaneous combustion; detection and monitoring

techniques, Prevention and control of mine fires; fire stoppings and sealing of fire areas. Direct and indirect methods of dealing with mine fires; reopening sealed areas, Mine explosions: firedamp explosions, explosive limits, and causes, Coal dust explosions; prevention measures and Ellicot's explosibility graph, Intrinsically safe apparatus, flameproof enclosures, and ingress protection, Mine inundation: causes, prevention, and design of water dams, Approaching old workings; precautions and dewatering of waterlogged mines, Rescue and recovery: rescue equipment, apparatus classification, artificial respiration techniques, Emergency organization, locating trapped miners, recovery of injured persons, and first aid, Airborne respirable dust, dust diseases, sampling, suppression, and illumination standards in mines.

Ramlu, M. A. (1991). Mine Fires, Explosions, Rescue, Recovery & Inundations. Oxford & IBH Publishing; Rakesh & Lele, M. G. (1970). Inundation in Mines; Chaulya, S. K., & Prasad, G. M. (2016). Sensing and Monitoring Technologies for Mines and Hazardous Areas. Elsevier.

MN302N MINERAL PROCESSING TECHNOLOGY (2-0-2) 3

Importance of minerals in economy; role of beneficiation in metallurgical industries, Concept of liberation and importance in mineral processing, Theories of comminution and energy considerations, Crushing equipment, grinding mills, applications, and limitations, Comminution circuits and their design considerations, Sizing techniques and industrial screening methods. Performance of screens and interpretation of sizing data, Laws of settling and classification of particles in fluids, Types of classifiers and their selection and performance, Gravity concentration and dense media separation techniques. Magnetic, electrostatic separation, and flotation methods, Beneficiation of low-grade ores and coal preparation techniques, Solid-liquid separation: thickeners and filtration systems, Plant practices: flow sheets, metallurgical accounting, and process control.

Gupta, A., & Yan, D. S. (2003). Principles of Mineral Processing. SME; Ramakrishna Rao, G. S. (2016). Mineral Processing Design and Operations. Elsevier; Weiss, N. L. (1985). Mineral Processing Handbook, Vols. 1–2; Wills, B. A. (1989). Mineral Processing Technology (4th ed.); Mineral Processing Techniques: Basics and Related Issues. Zorba Publishers.

MN303N HEALTH AND SAFETY ENGINEERING (1-1-2) 3

Illumination standards and visual fatigue in workplaces, Whole body vibration and musculoskeletal disorders in mining operations, Principles of accident analysis and accident causation theories, Accident investigation procedures and accident reporting methods, Safety performance indices: frequency rate, severity rate, and accident statistics, Risk management terminology and basic concepts of hazard and risk. Risk management objectives and risk management process, Risk estimation techniques and qualitative risk assessment methods, Risk control strategies and hierarchy of control measures, Safety management systems and preparation of safety management plans, Case studies on occupational safety and risk management in mining operations, Whole body vibration and musculoskeletal disorders in mining operations, Illumination standards and visual fatigue in workplaces. Principles of accident analysis and accident causation theories.

Ramlu, M. A. (1991). Mine Fires, Explosions, Rescue, Recovery & Inundations. Oxford & IBH Publishing; Rakesh & Lele, M. G. (1970). Inundation in Mines; Chaulya, S. K., & Prasad, G. M. (2016). Sensing and Monitoring Technologies for Mines and Hazardous Areas. Elsevier.

MN304N MINE LEGISLATION AND MANAGEMENT (3-0-0) 3

History and development of mine legislation in India; regulatory framework overview, Payment of Wages Act and Provident Fund Act: important statutory provisions, Mines Act 1952: objectives, definitions, and key provisions, Mines Rules 1955: provisions related to working conditions and employee welfare, Coal Mines Regulations 2017: safety, health, and operational requirements, Metalliferous Mines Regulations 1961: key provisions and applicability, Mines and Minerals (Regulation and Development) Act 1958: provisions and amendments, Mineral Conservation and Development Rules 2016: objectives and applicability, Mines Rescue Rules 1985 and Vocational Training Rules 1966. , Indian Electricity Rules 1956: provisions applicable to mining

operations, Accident causes, preventive measures, and accident analysis statistics. Safety management plans, safety audits, and accident enquiry reports, Important DGMS circulars: safety directives and compliance requirements. National Mineral Policy 2019: classification of minerals and policy implications.

Rakesh and Prasad, N. (1986). Legislation in Indian Mines: A Critical Appraisal. Ashalata Publications. Singh, C. P. (2004); Occupational Safety and Health in Industries and Mines. Tata McGill; Directorate General of Mines Safety. (n.d.). The Mines Act, Rules and Regulations. Commercial Law Publishers / Universal Law Publishing.

MN350N APPLIED MINE SURVEYING (3-0-0) 3

Basic principle of triangulation survey, Signals, towers and satellite station, Principles of tacheometry surveying, Various methods of tacheometric surveying, Principles of curve ranging and laying of curves in surface and underground, Aerial photogrammetry and field astronomy, Principles of correlation survey – Transferring coordinates and Correlation survey - Transferring RL, Total Station, GPS and DGPS, Solving problems, Drone surveying, Plans, Sections and IBM Rules & Regulations

Punmia, Surveying Vol - I, II & III; Kanetkar, Surveying, Vol – I, II & III; S. K. Duggal, Surveying, Viol. I & II; Ghatak, Mine surveying, Vol - I, II, III.

MN351N NOISE POLLUTION AND CONTROL (3-0-0) 3

Noise measurement techniques for individual noise sources, Noise measurement practices in industrial, Noise measurement practices in community environments, Basic principles of noise control engineering, Noise control in underground mining machinery and equipment, Noise control in heavy earth moving machinery and mineral processing plants, Hearing protective devices: types, working principles, and noise reduction capabilities, Noise impact prediction using mathematical Modelling techniques, Noise pollution assessment and management in industrial sectors, Noise abatement methods: sound absorption, acoustic barriers, vibration isolation, and damping, Noise-induced human vibration, health effects, and control measures, Noise control measures.

Harris, C. M. (1979). Handbook of Noise Control. McGraw-Hill; Pal, A. K., & Saxena, N. C. (1999). Noise Pollution in Coal Mining Complexes. ENVIS Centre of Mining Environment, ISM; Thumann, A., & Miller, R. K. (1976). Secrets of Noise Control. The Fairmont Press.

MN352N PRODUCTION DRILLING FOR OIL WELLS (3-0-0) 3

Introduction to oil wells and petroleum drilling operations, Drilling rigs and systems; rotary drilling fundamentals, Drill bits: tricone roller and PDC bits, Drill string components and pipe handling practices, Drilling fluids: functions and properties, Basic drilling hydraulics and circulation systems. Drilling problems: stuck pipe, lost circulation, twist-offs, Routine drilling operations and logging techniques, Well control principles and kick detection. Blowout prevention and shut-in procedures, Directional drilling basics and downhole tools, Well completion: casing design, cementing, integrity testing, Well stimulation methods: acidizing and hydraulic fracturing, Case studies in oil well drilling operations.

Conaway, C. F. The Petroleum Industry; Gerding, M. Fundamentals of Petroleum (3rd ed.).

MN353N STRATA MECHANICS (3-0-0) 3

Introduction to strata mechanics; scope and significance in mining, Differences between rock mechanics and strata mechanics; strata control objectives, Strata conditions before and after mining operations, Theories of strata behavior and ground movement, Stress redistribution in bord and pillar workings and longwall mining systems, Ground movement monitoring techniques and instrumentation, Instruments: extensometers, telltales, stress meters, LVDT, vibrating wire devices, In-situ stress measurement techniques: flat jack, over-coring, hydraulic fracturing, Pillar design, functions, failure mechanisms, and stability assessment, Subsidence:

mechanisms, prediction, and control methods, Rock bursts: causes, prediction, and mitigation techniques. Caving, cavability index, and applications in mining, Rock mass classification systems (RMR, Q, GSI) and support design.

Deb, D., & Verma, A. K. (2025). Fundamentals and Applications of Rock Mechanics (2nd ed.). PHI Learning; Galvin, J. M. (2016). Ground Engineering for Underground Coal Mining. Springer; Hartman, H. L. (Ed.). SME Mining Engineering Handbook; Jeremic, M. L. (1985). Strata Mechanics in Coal Mining; Peng, S. S. (1978). Coal Mine Ground Control. Wiley.

MN354N ADVANCED SURFACE MINING TECHNOLOGY (3-0-0) 3

Detailed classification of surface mining equipment's and their constructional features, Operational features of HEMM, Unit operations in surface mine projects, Selection of machinery for various operations, Loading equipment's - Cyclic type and Continuous type, Transporting equipment's – Cyclic type and Continuous type, Auxiliary/Miscellaneous equipment's, Applicability, equipment selection criteria and inputs, Computations for the capacity and number of machines vis-à-vis mine production, DGMS regulations pertaining to safety of HEMM, Advanced surface mining methods, Maintenance of HEMM, Automation and application of IoT in HEMM.

Martin & Martin, 1982, Surface Mining Equipment, Martin Consultants, U.S.A; Amithish Dey, Latest Developments of Heavy Earth Moving Machinery, Dhanbad Book Stores; Hartman H. L. Introductory Mining Engineering, John Wiley & Sons.

MN355N MECHANIZATION AND MATERIALS HANDLING (3-0-0) 3

Introduction to mechanization and materials handling in mining, Locomotive haulage systems and rolling stock, Haulage calculations and performance analysis, Belt conveyors: components and working principles. Conveyor capacity, tension, and power calculations, Safety devices and cable belt conveyors, Intermediate storage and in-pit crushing systems, High-angle conveyors and loading systems, Slurry transport and pipeline systems, Face machinery and productivity of loading machines, Material handling systems in opencast mining. Aerial ropeways: design, construction, and calculations, Plant layout: hydraulic, pneumatic stowing and paste filling, Automation, maintenance, and safety in materials handling systems.

Deshmukh, D. J. (1994). Elements of Mining Technology, Vol. 3; Morley, L. A. (1990). Mine Power Systems; Ramlu, M. A. (1996). Mine Hoisting; Reese, C. (2000). Material Handling Systems; Tatiya, R. R. (2005). Surface and Underground Excavation; Walker, S. C. (1988). Mine Winding and Transport.

MN400N ROCK FRAGMENTATION ENGINEERING (2-1-0) 3

Bulk Explosive Systems, Blast Designs, Substitutes for Explosives, Mechanisms of Rock Fragmentation Due to Blasting: Theories and importance, Prediction and assessment of fragmentation, Environmental Effects of Rock Blasting, Controlled blasting techniques, Under water blasting, Case studies of mining and infra projects, Various Legal Aspects Related to Rock Blasting, Economic evaluation of blasting projects, Overview of Different Software Used in Blast Design and Assessment.

Bhandari, S. (1997). Engineering rock blasting. A. A. Balkema; Konya, C. G. (1989). Blast design. CRC Press; Persson, P. A. (1986). Rock fragmentation. International Development Corporation.

MN401N DATA ANALYTICS IN ENGINEERING (2-0-2) 3

Introduction to data analytics in engineering and mining applications, Data-driven decision-making and data types in mining, Statistical techniques for geological and geotechnical data analysis, Regression and classification techniques in engineering analytics, Data analytics in mine safety and risk assessment, Predictive analytics for injury and accident data, Sensor-based data analytics for fatigue and worker health monitoring, Hazard prediction using machine learning models, Case studies on accident prevention using

AI/ML. Predictive Modelling of rock characterization using deep learning, Seismic data analysis in underground mining, Data visualization and interpretation techniques, Applications of analytics in operational optimization. Integrated case studies and project-based applications.

Maiti, J. (2020). Multivariate Statistical Modelling in Engineering and Management. CRC Press; Soofastaei, A. (2020). Data Analytics Applied to the Mining Industry. CRC Press.

MN402N RELIABILITY ENGINEERING (2-1-0) 3

Introduction to reliability, quality, and system performance, Reliability in system life cycle and engineering applications, Failure concepts, failure modes, and causes of failure, Maintainability and availability concepts, Reliability improvement techniques. Reliability block diagrams: series and parallel systems, Combined systems and redundancy concepts, FMECA and failure analysis techniques, FRACAS and reliability data management, Fault tree analysis (FTA) and system failure analysis, Markov models and system state analysis, Availability, downtime, and performance measures, Reliability-centered maintenance and applications. Reliability management, culture, and software applications.

Ebeling, C. E. (2017). Reliability and Maintainability Engineering. Tata McGraw Hill; Kapur, K. C., & Pecht, M. (2014). Reliability Engineering. Wiley.

MN403N ROCK EXCAVATION ENGINEERING (3-0-0) 3

Introduction to rock excavation in mining and infrastructure projects, Excavation methods: drilling and blasting, mechanical excavation, Excavation equipment and material handling systems, Selection criteria for excavation equipment, Excavation planning and project management principles, Excavation in sensitive and urban areas. Differences between mining and infrastructure excavation projects, Environmental impact assessment in excavation projects, Environmental management and mitigation measures, Economic evaluation of excavation projects, Case studies: mining, quarry excavation, tunneling and underground projects, Case studies: hydel, pipeline, and canal excavation projects, Case studies: large caverns and infrastructure excavation projects.

Balci, C. et al. (2013). Mechanical Excavation in Mining and Civil Industries. CRC Press; Bhandari, S. (1997). Engineering Rock Blasting; Ghose, A. K., & Singh, R. N. (2006). Engineered Rock Structures.

MN404N TUNNELING AND UNDERGROUND SPACE ENGINEERING (3-0-0) 3

Introduction to tunneling and underground space engineering, Historical developments and scope of tunneling, Types of underground excavations and influencing parameters, Geological investigations and rock mass classification, Stress distribution around tunnels and design considerations, tunneling methods: soft ground and hard rock tunneling. Shallow and deep tunneling techniques, Drilling pattern and blast design in tunnels, tunneling by road headers and impact hammers, Tunnel boring machines: principles, selection, and performance, NATM and modern tunneling approaches, Tunnel supports and ground treatment techniques. Tunnel services: ventilation, drainage, illumination, communication, Excavation of large caverns and tunneling hazards.

Bickel, J. O. et al. (1997). Tunnel Engineering Handbook; Clark, G. B. (1987). Principles of Rock Fragmentation; Hudson, J. A. Rock Engineering Systems; Johansen & Mathiesen (2000). Modern Trends in Tunnelling.

MN405N APPLICATION OF GEOINFORMATICS IN MINING (3-0-0) 3

Basics of geographic information systems and spatial data concepts, Remote sensing principles, sensors, platforms, and satellite imagery, Fundamentals of GPS/GNSS and positioning techniques, Applications of GIS in mineral exploration and resource mapping, Use of remote sensing in mine planning and surface mapping. Haul road alignment and mine infrastructure planning using GIS, Overburden dump monitoring and slope stability analysis using geospatial data, Subsidence monitoring and deformation analysis using remote sensing

techniques, Land use and land cover change detection in mining areas, Mine water drainage analysis and watershed mapping using GIS. Mine reclamation and land rehabilitation planning using geospatial techniques, Environmental impact assessment using geoinformatics tools, Basics of geographic information systems and spatial data concepts, Remote sensing principles, sensors, platforms, and satellite imagery.

Bhatta, B. (2016). Remote Sensing and GIS (2nd ed.). Oxford Publishing House; El-Rabbany, A. (2002). Introduction to GPS: The Global Positioning System. Artech House; Lillesand, T., & Kiefer, R. W. (2015). Remote Sensing and Image Interpretation (7th ed.). John Wiley & Sons.

MN406N ROCK SLOPE ENGINEERING (3-0-0) 3

Introduction to slope stability in surface mines. Mechanisms of slope failures: planar, circular, wedge, and toppling failures, Description, derivation, and calculation of different slope failure mechanisms, Field investigations and data collection methods: geological mapping, discontinuity surveys, and sampling techniques, Geotechnical investigations and characterization of rock and soil masses for slope stability assessment, Laboratory testing methods: density, moisture content, strength properties, and permeability tests, Design of mine slopes using limit equilibrium analysis methods, Numerical Modelling techniques for slope stability analysis and interpretation of results, Slope stabilization methods: mechanical, drainage, reinforcement, retaining structures, and their applications, Slope failure monitoring techniques: total station monitoring and extensometers, Advanced monitoring systems: crack meters, borehole extensometers, and slope stability radar, Case studies of slope failures and stabilization practices in surface mines, Relevant mining statutes, regulations, and best practices related to slope stability and monitoring in surface mines.

Brawner, C. O. (1982). Stability in surface mining. Society for Mining, Metallurgy, and Exploration; Deb, D. and Verma, A. K. (2025). Fundamentals and applications of rock mechanics (2nd ed.). PHI Learning Pvt. Ltd.; Giani, F. (1992). Rock slope stability analysis; Hoek, E. and Bray, J. W. (1984). Rock slope engineering. John Wiley & Sons.

MN450N INDUSTRIAL ENGINEERING AND MANAGEMENT (3-0-0) 3

Concepts of management and organization; functions of management, Organizational structures and departmentation, Motivation theories and workplace behavior, Leadership styles and effectiveness, Group dynamics and conflict management, Introduction to work study and productivity improvement, Time study techniques and work measurement. Job evaluation methods and wage determination, Project management fundamentals and life cycle. Network techniques: CPM and PERT, Human resource management principles, Total quality management concepts and tools, Job satisfaction and organizational behavior, Case studies in industrial engineering and management.

Khanna, O. P., & Rai, D. (2005). Industrial Engineering and Management; Barnes, R. M. Motion and Time Study; Besterfield, D. H. Total Quality Management; Chase et al. (2003). Operations Management; Koontz & Weihrich. Principles of Management.

MN451N COAL BENEFICIATION (3-0-0) 3

Introduction to coal beneficiation and its importance, Coal quality parameters and classification of coal, Washability characteristics and sink-float analysis. Washability index and degree of washability, Coal washeries and preparation plant operations, Jigs and heavy media cyclone applications, Coal cleaning techniques for coarse coal, Fine coal beneficiation and flotation techniques, Beneficiation of non-coking coal and dry beneficiation methods, Automation and quality control in coal preparation plants, Environmental management in coal beneficiation, Coal handling plant layout and operation. Coal transportation systems and material handling, Case studies in coal beneficiation and plant performance.

Muthui, R. K. et al. (2014). Coal Handling and Equipment Selection; Prochaska, E. Coal Washing; Weiss, N. L. (1985). Mineral Processing Handbook, Vol. 2

MN452N MINE POWER SYSTEM (3-0-0) 3

Electric power in mining; Three-phase circuit analysis, Mine power system components, basic mine power distribution arrangements, Distribution of electrical power in surface and underground mines, Grounding systems, ground wire monitoring; Distribution cable construction and selection, stresses in cables, cable codes, Power flow calculations, power factor correction, Design of substations, switch houses and power centers, Substation grounding and protection, Method of symmetrical components and mine power system fault analysis, Transients and overvoltages in mine power systems, Mine power system protection equipment and relaying, Relaying schemes for overload, phase-to-phase and ground fault protection, Legislative and safety aspects.

Morley, L.A., Mine Power Systems, US Bureau of Mines Information Circular 9258, 1990; Stevenson, W.D., Elements of Power System Analysis, 4th Edition, McGraw Hill, 1982; Kothari, D.P. and Nagrath, I.J., Modern Power System Analysis, 4th Edition, McGraw Hill, 2011.

MN453N GEOSTATISTICS (3-0-0) 3

Introduction to Statistical Theory and Geostatistics Concepts: Principles, Introduction to Statistical Theory and Geostatistics Concepts: applications, advantages/disadvantages, limitations, Sampling: Sample preparation and data collection, Sampling: types, methods, procedures, Assaying: Assay methods and data collection; types, methods, procedures, Resources Estimation Techniques: Concepts of nugget, sill, range; regionalized variables; geometric methods, Resources Estimation Techniques: geometric methods; Variance: Concepts, computations, Modelling; Variogram: Functions, mathematical models, computations, Modelling, Resources Estimation Techniques: Semi-variogram: Functions, mathematical models, computations, Modelling; Kriging: Concepts, types, practices, Geostatistical Conditional Simulation Methods: Resource estimation, Geostatistical Conditional Simulation Methods: methods, methodology, Case Studies of Geostatistics Applications in mining, Case Studies of Geostatistics Applications in Different Areas.

Chilès, J.-P. and Delfiner, P. (1999). Geostatistics: Modelling spatial uncertainty. John Wiley & Sons; Gandhi, S. M. and Sarkar, B. C. (2016). Essentials of mineral exploration and evaluation. Elsevier; Kitanidis, P. K.(1997). Introduction to geostatistics: Applications in hydrogeology. Cambridge University Press; Lantuéjoul, C. (2002). Geostatistical simulation: Models and algorithms. Springer; Deshmukh, D. J. (n.d.). Elements of mining technology (Vol. 3). Central Techno Publications.

MN454N INSTRUMENTATION, COMMUNICATION, AND AUTOMATION (2-1-0) 3

Introduction to digital mine and smart mining concepts, LiDAR survey and 3D virtual mine Modelling, Real-time sensor data visualization and asset tracking systems, Miner tracking and hazard warning systems. Mine transport surveillance in opencast mines, GPS-RFID tracking, weighbridge automation, and access control systems, Wireless communication, V2X communication, and CCTV analytics, Slope monitoring, radar systems, and centralized surveillance. Underground monitoring: gases, dust, DPM, and safety systems, Strata monitoring, fire detection, and environmental monitoring systems, Underground communication: leaky feeder, Wi-Fi, and optical fiber systems, Trapped miner communication and integrated communication systems, Automation: pump, fan, conveyor, and traffic management systems, OITDS, collision avoidance systems, and centralized mine automation.

Bandyopadhyay, L. K. et al. (2014). Wireless Communication in Underground Mines. Springer; Chaulya, S. K., & Prasad, G. M. (2016). Sensing and Monitoring Technologies for Mines. Elsevier.

MN455N MINE CONTRACT MANAGEMENT AND CLEARANCES (3-0-0) 3

Introduction to mine contract management and MDO model in mining industry, Definitions and interpretation of key contractual terms and legal provisions, Scope of mining project; mining rights and compliance requirements, Appointment of Mine Developer and Operator; substitution and contractual obligations,

Responsibilities of MDO: development, operation, safety, environment, and reporting, Responsibilities of grantor: access, approvals, and payment obligations, Payment terms: structure, schedule, and financial considerations in contracts, Project timelines and milestones; monitoring and performance evaluation, Force majeure clauses: events, risks, and contractual implications, Termination clauses and procedures in mining contracts. Dispute resolution mechanisms and legal frameworks, Statutory clearances: prospecting license, mining lease, forest and environmental clearance, Pollution control consents under Air Act, Water Act; electrical and fire safety approvals. Land acquisition, rehabilitation and resettlement; compliance and case studies.

Model Mine Developer and Operator (MDO) Agreements (Government of India); Relevant provisions of Mining Laws, Environmental Laws, and DGMS Guidelines; Industry reports and case studies on mining contracts and clearances

CE207N MINING GEOLOGY (2-0-0) 2

General Geology: Interior of the Earth and Plate tectonics; Mineralogy and Petrology; Structural Geology: Dip and Strike, study of folds, faults, Joints, unconformities; Economic Geology: Magmatic, Hydrothermal, Sedimentary, Metamorphic deposits, oxidation and supergene enrichment, study of Gold, Iron, copper, lead, Zinc, Chromite, manganese, bauxite, mica, asbestos deposits. Exploration Geology: Stage of mineral exploration, Geological, Geophysical, geochemical and remote sensing methods of exploration. Applied Geology; Sampling, guides for locating ore deposits, geological mapping, Hydrogeology

Arogya Swamy, Courses in Mining Geology, Oxford & IBH, 1988
Haakon Fossen, Structural geology. Cambridge University Press, 2016.
Parbin Singh, Engineering and General Geology, Katson Pub., Delhi, Sixth edition 2001
Umeshwar Prasad, Economic Geology: Economic Mineral Deposits. CBS Pub., 2006.

CE257N MINING GEOLOGY LAB (0-0-2) 1

Identification of rock-forming minerals - Identification of ore-forming minerals - Identification of rocks (Igneous – Sedimentary – Metamorphic) – Interpretation of Geological Maps and cross sections - Interpretation and Analysis of Dip, Strike, Thickness and borehole problems in mining

Bose, N., & Mukherjee, S. (2017). Map interpretation for structural geologists (Vol. 1), Elsevier.
Rutley, F. (2012). Rutley's elements of mineralogy. Springer Science & Business Media.

MN398N/ MN448N/ MN498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

MN399N MAJOR PROJECT - I (0-0-18) 9

The students jointly or individually will be assigned an experimental or a theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VI, VII & VIII semester. The students should complete the preliminary literature survey and a part of the work in the VII semester. Their work will be reviewed and evaluated.

MN449N	**MAJOR PROJECT - II**	**(0-0-18) 9**
MN499N	**MAJOR PROJECT - III**	**(0-0-18) 9**

Honors Courses:

Students seeking an Honors degree shall earn a minimum of 15 additional credits from Postgraduate courses offered by the respective Department, as decided by the DUGC.

Department of Metallurgical and Materials Engineering (MT)
Bachelor of Technology in Metallurgical and Materials Engineering

Basic Science Core Courses (BSC)

PH100N	Engineering Physics	(3-0-2)4
CY100N	Engineering Chemistry	(3-0-2)4
MA107N	Multivariable Calculus	(3-0-0)3
MA101N	Ordinary and Partial differential Equations	(3-0-0)3
UC102N	Biology and Environment	(3-0-0)3
UC103N	Indian Knowledge System	(3-0-0)3

General Engineering Courses (GEC)

UC101N	Introduction to Engineering	(2-0-2)3
CS101N	Computer Programming	(0-0-6)3
UC100N	Data Science and AI	(2-0-2)3
DE100N	Design Thinking and Prototyping	(2-0-2)3

Life-Skill Courses (LSC)

PL1XWN	Life skill - Activities - 1	(0-0-8)4
PL1YWN	Life skill - Activities - 2	(0-0-8)4
PL2XWN	Life skill - Activities - 3	(0-0-8)4
PL2YWN	Life skill - Activities - 4	(0-0-8)4
PL3XWN	Life skill - Activities - 5	(0-0-8)4

NCC Option under Life Skill Courses (LSC)

PL1X9N	NCC - Activities - 1	(0-0-8)4
PL1Y9N	NCC - Activities - 2	(0-0-8)4
PL2X9N	NCC - Activities - 3	(0-0-8)4
PL2Y9N	NCC - Activities - 4	(0-0-8)4
PL3X9N	NCC - Activities - 5	(0-0-8)4

The actual activity-specific course code shall depend upon the Life-Skill activity/NCC option undertaken by the individual student.

Internship/Major Project Courses (IPC)

Programme Core Courses (PCC)

MT200N	Physical Metallurgy	(2-1-0)3
MT201N	Metallurgical Thermodynamics and Kinetics	(2-1-0)3
MT202N	Extractive Metallurgy	(2-0-2)3
MT203N	Ceramics and Refractories	(2-0-2)3
MT204N	Polymer Science and Technology	(2-0-2)3
MT205N	Physical Metallurgy and Metallography Lab	(0-0-6)3
MT250N	Transport Phenomena	(2-1-0)3
MT251N	Iron and Steel Making	(2-1-0)3
MT252N	Phase Diagrams and Phase Transformations	(2-1-0)3
MT253N	Heat Treatment	(2-0-2)3
MT254N	Materials Characterization	(2-0-2)3
MT300N	Mechanical Behaviour of Materials	(2-0-2)3
MT301N	Metal Casting & Joining of Materials	(2-0-2)3
MT302N	Manufacturing Processes: Powder Metallurgy & Metal Forming	(2-1-0)3
MT303N	Corrosion Engineering	(2-0-2)3
MT304N	Computational Materials Science	(1-1-2)3

Department/Institute Elective Courses (DEC)

MT350N	Fatigue, Fracture and Creep	(3-0-0)3
MT351N	Extraction of Non-Ferrous Metals	(3-0-0)3
MT352N	Secondary Refining of Steels	(3-0-0)3
MT353N	Process Plant Materials	(3-0-0)3
MT354N	Fuels and Furnaces	(3-0-0)3
MT355N	Machine Design	(3-0-0)3
MT356N	Modelling and Simulation in Materials Processes	(3-0-0)3
MT400N	Nuclear Materials	(3-0-0)3
MT401N	Composite Materials	(3-0-0)3
MT402N	Surface Engineering	(3-0-0)3
MT403N	Sustainable Metallurgy	(3-0-0)3
MT404N	Non-Destructive Testing	(3-0-0)3
MT405N	Aerospace Materials	(3-0-0)3
MT406N	Thin Films, Coatings and Applications	(3-0-0)3
MT450N	Science and Technology of Nanomaterials	(3-0-0)3
MT451N	Advanced Microscopic Techniques	(3-0-0)3
MT452N	Smart Materials and Sensors	(3-0-0)3
MT453N	Advanced Welding Technology	(3-0-0)3
MT454N	Advanced Engineering Materials	(3-0-0)3
MT455N	Recycling and Circular Economy	(3-0-0)3
MT456N	Bio-materials	(3-0-0)3
MT398N	Internship-I	(0-0-18)9
MT399N	Major Project-I	(0-0-18)9
MT448N	Internship-II	(0-0-18)9
MT449N	Major Project -II	(0-0-18)9
MT498N	Internship-III	(0-0-18)9
MT499N	Major Project- III	(0-0-18)9

Honors Courses

Students seeking Honors degree shall credit minimum FIFTEEN (15) additional credits from minimum FIVE Postgraduate courses offered by the Department of Metallurgical & Materials Engineering as decided by Department Under Graduate Committee (DUGC).

Minor Courses (MN)

MT200MN	Physical Metallurgy	(2-1-0)3
MT204MN	Polymer Science & Technology	(2-0-2)3
MT252MN	Phase Diagrams & Transformations	(2-1-0)3

MT202MN	Extractive Metallurgy	(2-0-2)3
MT203MN	Ceramics & Refractories	(2-0-2)3

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
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Suggested Plan of Study for B.Tech. in Metallurgical and Materials Engineering:

Semester	I	II	III	IV	V	VI	VII	VIII
1	PH100N	CY100N	MT200N	MT250N	MT300N	MT398N/ MT399N	MT448N/ MT449N	MT498N/ MT499N
2	MA107N	MA101N	MT201N	MT251N	MT301N	Elective	Elective	Elective
3	UC102N	UC103N	MT202N	MT252N	MT302N	Elective	Elective	Elective
4	UC101N	UC100N	MT203N	MT253N	MT303N	Elective	Honors / Minor (Optional)	Honors / Minor (Optional)
5	CS101N	DE100N	MT204N	MT254N	MT304N	Elective		
6	PL1XWN/ PL1X9N	PL1YWN/ PL1Y9N	MT205N	PL2YWN/ PL2Y9N	PL3XWN/ PL3X9N	Honors / Minor (Optional)		
7			PL2XWN/ PL2X9N	Honors / Minor (Optional)	Honors / Minor (Optional)			

Requirements for B.Tech. in Metallurgical and Materials Engineering:

Category of Courses	Minimum Credits to be Earned
Basic Science Courses (BSC)	20
General Engineering Courses (GEC)	12
Life Skill Courses (LSC)	20
Programme Core Courses (PCC)	48
Dept/Institute Elective Courses (DEC) MOOC Courses (0 – 8 credits)	24
Internship/Major Project Courses (IPC)	27
Total	151

Requirement for Honors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

Requirement for Minors:

Minimum No. of Courses to be Registered	Minimum Credits to be earned
5	15

MT200N PHYSICAL METALLURGY (2-1-0) 3

Structure of metals, space lattice, unit cells, crystal systems metallic crystal structures packing efficiencies, Voids, Indexing of Crystallographic planes and directions and their role in material properties and performance, Types of solid solutions, Hume Rothery rules, Intermediate phases: Intermetallic compounds, Interstitial compounds, Electron compounds, Solidification of metals, Dendritic freezing of alloys, freezing of ingots, Porosity, homogeneous and heterogeneous nucleation, critical radius, Eutectic freezing, Macro defects—Shrinkage, Blow holes, Segregation and Other defects, Binary isomorphous system, phase rule and lever rule, Equilibrium solidification, non-equilibrium solidification, Coring. Homogenization, Micro defects: Point Defects, Line defects, Surface defects, Hot and cold working, no recrystallization temperature, Effect of temperature, composition and grain size on strain hardening, Recovery, recrystallisation and grain growth, High temperature deformation of crystalline materials, Diffusion in solids, Applications of second law of diffusion, Kirkendal effect, Application of diffusion

Sidney H. Avner, Introduction to Physical Metallurgy, McGraw Hill International Editions, 2nd edition, 19743rd Edition, 1991.
Physical Metallurgy Principles, T. E. Reed-Hill and R. Abbaschian, Thompson Asia Pvt. Limited,
V. Raghavan, Physical Metallurgy, Principles and Practice, Prentice-Hall of India Private Limited, New Delhi, 2003
V. Raghavan, Materials Science and Engineering-A first course, Prentice-Hall of India Pvt. Ltd. New Delhi, 6th edition, 2017
Mechanical Metallurgy, George E Dieter, McGraw -Hill Book Company, SI Metric Edition, 1988.

MT201N METALLURGICAL THERMODYNAMICS AND KINETICS (2-1-0) 3

Historical milestones in Chemical Thermodynamics, Zeroth and I Law of Thermodynamics and their significance, Systems, state variables and equilibrium, 2nd and 3rd laws of thermodynamics and their significance, Review of heat capacity, enthalpy, entropy and free energy concept, Tabular representation of thermodynamic data and the free energy function, Ellingham diagrams. Applications and limitations, Concept of fugacity, activity, activity coefficient and the equilibrium constant and reaction feasibility. Thermodynamics of oxidation and reduction, Solutions – Concept of chemical potential, partial molar properties, Raoult's law and Henry law, Properties of Raoultian ideal solutions, Sievert's law, Non-ideal solutions, Mixing and Excess thermodynamics functions, Concept of real and regular solutions. Binary Gibbs-Duhem equation and its derivation, Integration of Gibbs-Duhem equation, Application to activity and activity coefficient determination. Activity determination in Multicomponent solutions, alternative standard states, interaction parameters and interaction coefficients, Statistical model of Regular solutions, Modified Regular solution model applicable to polymers, subregular solution models, activity determination, Free energy composition diagrams behind phase diagrams, Thermodynamics of Electrochemical Cells, Lithium Ion batteries, SEI formation, Wagner's Transport equation, Solid electrolytes, Metallurgical kinetics, order of a chemical reaction, Rate equations, Collision, Transition state and Quantum Transition State Theories of Reaction Rates, Transformation kinetics in gas-solid reactions, Transformation of a dense solid particle by a gas under chemical, diffusion and mixed regimes

D. R. Gaskell, Introduction to Thermodynamics of Materials, CRC Press, 2008.
G.S. Upadhyaya and R.K. Dube, Problems in Metallurgical Thermodynamics and Kinetics: International Series on Materials Science and Technology (Materials Science & Technology Monographs) (Volume 25)) Pergamon Press, 1977.
R. T. Dehoff, Thermodynamics in Materials Science, McGraw Hill, 1993 Prentice-Hall, New Delhi, 2003
Treatise on Process Metallurgy, Vol. 1, Eds. Seshadri Seetharaman et al, Elsevier, 2024
Thermodynamics and Kinetics of Materials — NPTEL / SWAYAM
Advanced Metallurgical Thermodynamics — NPTEL / SWAYAM

MT202N EXTRACTIVE METALLURGY (2-0-2) 3

Introduction: Classification of mineral and ores and critical minerals. Sources of minerals: land, sea and ocean. Mineral beneficiation processes. Pyrometallurgical processes: Calcination, roasting, types of roasting, Ellingham diagram, predominance area diagram, smelting process: reduction and matte smelting. Hydrometallurgical processes: Pourbaix diagram, leaching process, type of leaching, microbial and solvent extraction, ion-exchange, precipitation, drying. Electrometallurgical processes: Electro-winning and electro-refining processes, aqueous salt and fused salt electrolysis of metals. Refining of metals: pyro, hydro, and electrometallurgical refining methods. Special techniques: vacuum arc re-melting, electron beam melting, and electro-slag re-melting. Aluminium extraction: Bayer process and Hall-Heroult process. Industrial practice in India (refinery and smelter units). ALCOA and ALCAN process. Copper extraction: Sources of copper, extraction from sulphide ores, refining, newer processes for copper extraction, hydrometallurgy of copper. Lead and zinc extraction: pyrometallurgical and hydrometallurgical extraction, recovery of byproducts, Imperial Smelting Process (ISP), lead blast furnace, refining. Perform pelletization of iron ore fines and measure pellet strength. Carry out reduction roasting of pyrolusite and determine reduction fraction. Investigate the froth flotation of a sulphide ore and determine metal recovery. Conduct acid leaching of bauxite ore in hydrochloric acid and analyze the leach liquor for iron. Measure the recovery of copper from copper sulphate solution by cementation process using iron.

H. S. Ray and A. Ghosh, Principles of extractive metallurgy, Wiley Eastern Ltd., New Delhi, 1991
H. S. Ray, R. Sridhar, and K.P. Abraham, Extraction of nonferrous metals, East West Press Pvt. Ltd., New Delhi, 2007.
M. Shamsuddin, Physical Chemistry of Metallurgical Processes, Second edition, R. D. Pehlke, Unit Processes of Extractive Metallurgy, Elsevier, New York, 1973.
S. Seetharaman (Ed.), Treatise on Process Metallurgy, Vol. 1, Elsevier, 2014.
F. Habashi, Principles of Extractive Metallurgy, Vol.1, Gordon and Breach, New York, 1969.
Principles of Extractive Metallurgy — NPTEL / SWAYAM
Non-Ferrous Extractive Metallurgy — NPTEL

MT203N CERAMICS AND REFRACTORIES (2-0-2) 3

Chemical bonding; Pauling's rules; Oxide structures; Silicate structures. Structure of glasses; Defects in ceramics, Kroger-Vink notation. Ceramic powder processing; forming of ceramics. Sintering – solid state and liquid phase sintering, grain growth. Microstructure of ceramics; Physical and thermal properties of ceramics. Mechanical properties of ceramics; brittle fracture; toughening mechanisms. Formation and properties of glasses; Cermet; Non-oxide ceramics; Cement; Advanced ceramics. Definition of refractory; Classification: Shaped and unshaped refractories; Properties and Testing of refractories; General Production method of refractories. Selection of refractories for metallurgical applications; Special types of refractories. Density measurement: bulk and apparent density; Estimation of open porosity percentage. Compressive strength measurement of the refractory bricks; Vickers' hardness. Microstructure of ceramics by Scanning Electron Microscopy.

Michel Baersoum, Fundamentals of ceramics, McGraw Hill, 1997.
W.D.Kingery, Introduction to Ceramics, Wiley Interscience, 1976.
F. H. Norton, Refractories, Mcgraw-Hill; 4 Reprint edition,1992.
A. R. Chesti, Refractories: Manufacture, Properties, and Applications, Prentice-Hall of India Private Limited, Delhi, 1986.

MT204N POLYMER SCIENCE AND TECHNOLOGY (2-0-2) 3

Introduction to polymers - nomenclature of polymers, polymer molecular architecture, Polymerization techniques – solution, bulk, suspension and emulsion, Polymer molecular weight determination – number average, weight average, Z-average, Industrial polymers - property Requirements and polymer utilization, thermoplastics: commodity and engineering plastics, Thermosets, elastomers, natural rubber and synthetic

rubbers, Thermoplastic elastomers, blends & reinforced polymers, Polymer Reactions: polymer modification, polymer degradation, Compounding and processing of polymers, Lab component: polymer synthesis, polymer processing, protein isolation and molecular weight determination, Polymer viscoelasticity: time - temperature superposition, Mechanical properties of polymer: stress-strain behaviour, fracture, creep, hardness, and impact behaviour, Basics of polymer rheology

R. O. Ebewele, Polymer Science and Technology, 1e, CRC Press, Boca Raton, 2000.
V. R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science, 1e, New Age International, New Delhi, 2011.
C.S. Brazel, S. L. Rosen, Fundamental Principles of Polymeric Materials, 3e, John Wiley, New York, 2012.
F. W. Billmeyer Jr., Textbook of polymer science, John Wiley, New York, 1996.
J. R. Fried, Polymer Science and Technology, 3e, PHI, 2014.

MT205N PHYSICAL METALLURGY AND METALLOGRAPHY LAB (0-0-6) 3

Polishing and etching of Steel, Polishing and etching Aluminum and Copper, Stainless Steels and Ni Alloys, Carbon Steels, Cast irons, Aluminum alloys, Copper alloys, Solders and Babbits, Weld inspection, Tools steels, Grain size measurement, Image analysis

Metallography Principle and Practice, Vander Voort
ASM Handbook Volume 9, Metallography

MT250N TRANSPORT PHENOMENA (2-1-0) 3

Units & Dimensions, properties of fluids, Newton's law of viscosity, momentum diffusivity, Newtonian and Non-Newtonian Fluids, Laminar flow, simple cases of flow (inclined plane, parallel plates, circular pipe), Equation of Continuity and Navier-Stokes Equation, Creeping flow around a sphere, Stokes law, Turbulent flows friction factor, flow over a flat plate and past submerged bodies, applications. Packed beds, Darcy's law, Tube Bundle Theory and Ergun's Equation, Fluidized beds, applications in industry, Bernoulli's Equation, friction loss in pipes, friction loss factor and entrance loss coefficient, flow through ladles, Pitot tubes, head meters, Flow of compressible fluids, isentropic flow, convergent-divergent nozzles, vacuum pumps, conductance and throughput, Fourier law of heat conduction, steady state heat transfer, concept of thermal resistance, critical thickness of insulation, Newtonian heat transfer, Unsteady state heat conduction, Semi-infinite and finite systems, error functions, Finite Difference techniques, Modelling of latent heat, Natural and Forced Convection, Dimensional analysis for the heat transfer coefficient, correlations in convective heat transfer, Radiation heat transfer, concept of black body, radiation resistance, radiation shields, radiation in gases, Similarity Criteria in heat transfer, Steady state diffusion, Fick's Ist law of Diffusion, logarithmic mean of concentration difference, Ordinary and Knudsen Diffusion, Unsteady state diffusion. Applications in microelectronic materials processing and homogenization heat treatment, Mass Transfer coefficient, mass transfer correlations, Models of Mass Transfer coefficient

D. R. Poirier and G. H. Geiger, Transport Phenomena in Materials Processing, TMS Warrendale, 1994, ISBN-10: 0873392728 | ISBN-13: 978-0873392723
N.J. Themelis, Transport and Chemical Rate Phenomena, Gordon Breach, 1995, ISBN-10: 2884491279 | ISBN-13: 9782884491273
B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, John Wiley & Sons, 2007, ISBN-10: 0470115394 | ISBN-13: 978-0470115398
Treatise on Process Metallurgy, Vol. 1, Eds. Seshadri Seetharaman et al, Elsevier, 2024
Transport Phenomena in Materials — IIT Madras / NPTEL via SWAYAM
Transport Phenomena — IIT Kharagpur / NPTEL via SWAYAM

MT251N IRON AND STEEL MAKING (2-1-0) 3

Introduction: History of ironmaking and steelmaking, routes of modern iron and steel making (BF-BOF, DRI-EAF, SR). Integrated steel plants. Blast Furnace ironmaking: Blast Furnace design, charging systems, various zones, chemical reactions, modern developments, productivity, and auxiliary systems. Blast Furnace aerodynamics: Ergun equation and irregularities. Physical chemistry of ironmaking: Heat and mass balance, RIST diagram, thermodynamics and kinetics. Raw materials: Iron ore, coal, coke, limestone, and quartz. Burden preparation: Sintering, pelletization, and coke making. Testing of raw materials. Direct Reduction (DR) processes: Coal and gas based (Rotary kiln, rotary hearth, Midrex, Fluidized bed, retort processes). Smelting Reduction (SR) processes: single, two and three stage processes (Romelt, Fastmelt, Corex, Finex, HIsmelt). Classification of steel making processes. Raw materials for steelmaking. Physical chemistry of steelmaking: Chemical reactions, thermodynamics and kinetics. Bessemer process, Open Hearth process. Oxygen steelmaking: top, bottom, and combined blown converters, rotary oxygen, LD converter, oxygen lance, reactions. Electric furnace steelmaking: AC and DC Electric Arc Furnace, Induction Melting Furnace. Stainless steel making. Secondary steelmaking processes: Ladle furnace, degassing process, injection ladle metallurgy, deoxidation of steel, inclusion and its control. Ingot casting and ingot defects. Continuous casting: equipment, principle, mould powder, improvements, casting defects and quality control. Pollution in iron and steel industries, carbon footprint, and green steelmaking. Waste management and recycling of iron and steel industry wastes.

A. Ghosh and A. Chatterjee, Ironmaking and Steelmaking: Theory and Practice, Prentice Hall of India, 2008.
S. K. Dutta and Y. B. Chokshi, Basic Concepts of Iron and Steel Making, Springer, 2020.
D. Mazumdar, A First Course in Iron and Steelmaking, Universities Press-IIM, 2015.
A. K. Biswas, Principles of Blast Furnace Ironmaking, SBA Publication, Kolkata, 1984.
Peacy and Davenport, The Iron Blast Furnace: Theory and Practice, Pergamon Press, Oxford, 1979.
R. H. Tupkary, and V. R. Tupkary, An Introduction to Modern Iron Making, Khanna Publishers, 2004.
R. H. Tupkary, and V. R. Tupkary, An Introduction to Modern Steel Making, Khanna Publishers, 2000.
Ironmaking and steelmaking – NPTEL / SWAYAM Steel Making – NPTEL

MT252N PHASE DIAGRAMS AND PHASE TRANSFORMATIONS (2-1-0) 3

Thermodynamic basics, Nucleation & Growth concepts. Solid solutions, One component systems, Isomorphous systems, Coring and it's control. Phase separation, Eutectic reactions, Kinetics & Microstructure management. Peritectic reactions, Intermediate phases, Miscibility gaps, Monotectic, Syntectic, Metatectic reactions. Kinetic aspects. Eutectoid reactions, Fe-Fe3C system. Theories of ferrite, cementite and pearlite formation and effect of cooling rate. TTT & CCT diagrams, Bainite formation. Martensite formation, Variants, Kinetics, Shape memory alloys. Al alloys, Types, Precipitation hardening, Cu alloys, Types, Order-disorder systems, Sinodal systems. Ternary systems, invariant systems, Concept of projections. Calculations in ternary systems.

Alloy Phase Equilibria, Allan Prince, 1966, Elsevier.
Ternary Phase Diagrams in Materials Science, 3rd ed., 2019, DRF West and N Saunders, CRC Press
Phase Transformations in Metals & Alloys, D A Porter and Easterling, 3rd ed., 1992, CRC Press
Physical Metallurgy Principles, R Abbaschian, L Abbaschian, R E Reed-Hill, 4th Ed., 2013
ASM Metals handbook, vol 3, Alloy Phase Diagrams, 2016, Ed: Okamoto H., et al.
Phase Transformation in Materials, Ed: Gernot Kostorz, Wiley, 2001.

MT253N HEAT TREATMENT (2-0-2) 3

Iron and its solid solutions, Fe-Fe_3C Phase Diagram, Heat treatment; Definition, Cycles, Parameters

Formation of Austenite, Decomposition of Austenite, TTT Diagrams (Eutectoid and non-eutectoid)

Pearlitic Transformation; Hull-Mehl model, Nucleation rate, Growth rate, Combined effect of N and G. Bainitic transformations; Upper Bainite, Lower Bainite. Martensitic Transformations; Bain Distortion model, Hardness, CCT diagrams. Common Heat treatments; Annealing (Full annealing, Isothermal annealing, Partial annealing, Diffusion annealing, Spheroidization Annealing), Normalizing, Hardening – Lab component, Hardening; Hardening methods, Tempering; Stages of tempering, Secondary hardening – Lab component, Quenchants; Heat removal by quenchants, Severity of quench, Discussion on various quenchants, Hardenability; Concept, Factors affecting hardenability, Determination of hardenability – Lab Component, Thermo-mechanical Treatments; Definition, Distinction between HTMT and LTMT, Important TMTs like Controlled rolling, Aus-forming, Iso-forming, Thermomechanical Annealing Surface Hardening Techniques: Flame hardening, Induction hardening, Laser hardening, Electron beam hardening, Carburizing (pack, liquid, gas), Nitriding, Carbo-nitriding – Lab component. Alloy Steels; Need for alloy addition, Classification of alloying elements, Effect of alloying elements (on Fe-Fe_3C diagram, on Hardness of ferrite, on TTT diagram), Heat treatment of Alloy steels (HSS, Maraging steels) - Lab component. Heat treatment Defects; Distortion, Quench cracks, Oxidation, Burning. Age hardening of Aluminium alloys – Lab component

R W K Honeycombe; "Steels –Microstructure and Properties", Edward Arnold (Publishers) Ltd., 1981
T E Reed Hill; "Physical Metallurgy principles", Affiliated East-West Press Pvt. Ltd, 1974
Donald S Clark "Physical Metallurgy for Engineers", CBS Publishers & Distributors, New Delhi, 1987
S H Avner, "Introduction to Physical metallurgy", McGraw-Hill Book Company, 1974
Vijendra Singh, "Heat treatment of Metals", Standard Publishers Distributors, New Delhi, 2009
T V Rajan, C P Sharma and Ashok Sharma,"Heat treatment- Principles and Techniques", PHI Publications, 2011
ASM International, Materials Park, OH, Volume 4A, Steel Heat Treating Fundamentals and Processes, 2013

MT254N MATERIALS CHARACTERIZATION (2-0-2) 3

Definition, Need, Classification, Standards, Imaging; Structural; Spectroscopic; Thermal techniques, Characterizations, Combination or hyphenated techniques. Structural characterization: Diffraction, X-ray and electron diffraction, Generation, Sources, filters, slits, Detectors, Powder diffraction, Bragg-Brentano, Thin film, Laue techniques, (Demo included). XRD patterns of Metals, ceramics and polymers, determination of structure, lattice parameter, density, Intensity, Hall-Scherrer (Demo included). Imaging techniques- Microscopy, Resolution, magnification, Depth of field, circle of least confusion, chromatic and spherical aberration, Astigmatism, Stereo microscope, Metallurgical microscope, Bright field, Dark field, DIC, Polarization, Confocal microscopy (Demo included). Scanning Electron Microscopy: Signals, construction, accelerating voltage, current, resolution, Working distance, SE, BSE, EDS, (Demo included). Compositional characterization- EDS, XRF, EPMA, OES, Bond Characterization: Raman and IR (Demo included), DSC, DTA, TGA, other techniques (Demo included), Optical Microscopy Lab, XRD Lab, SEM Lab, DSC and FTIR Lab, CRF Tour- Spark OES, ICP MS, TGA, LFA, Raman

Structure of Metals, C. Barrett and T B Massalski
Elements of X ray diffraction, B D Cullity and Stock
Scanning electron Microscopy and Micro-analysis, Dale E. Newbury, Joseph Goldstein, and Patrick Echlin
ASM handbook of Material Characterization
Materials Characterization by Prof. Shankaran of IIT Madras
Techniques of Material characterization by Prof. Shibayan Roy IIT Kharagpur

MT300N MECHANICAL BEHAVIOUR OF MATERIALS (2-0-2) 3

Force-Displacement Curve, Stress and Strain tensors;Yield criteria (Von Mises and Tresca). Theoretical shear strength, Dislocations and plastic deformation. Concept of dislocations, types of dislocations and Characteristics of Dislocations. Burgers vector, Energy of dislocations strain field associated with dislocations, dissociation of dislocations. Dislocations dynamics: Climb and cross slip, dislocation interactions, Lomar-Cottrell barrier. Plastic deformation by twin, stacking faults, Deformation bands and Kind bands. Macrostrain

behaviour, Dislocations point defects interaction, Yield point phenomenon, strain ageing. Strengthening mechanism: Strain hardening, Cold working, 3D network of dislocations, Strain hardening co-efficient significance and determination. Strengthening mechanism: Solid solution Strengthening and Grain refinement (Hall-Petch) Bauschinger effect, Effect of temperature on dislocations. Concept of linear viscoelasticity, phenomenological models (Maxwell, Kelvin-Voigt, and standard linear solid models). Room-temperature elastic behaviour of engineering ceramics and amorphous materials; reasons for lack of plastic deformation in ceramics and restriction of dislocation movement

G E Dieter, Mechanical Metallurgy, Tata McGraw-Hill, 2013, Indian Edition
Deformation and Fracture Mechanics of Engineering Materials, Richard W. Hertzberg, 2010 Indian Edition
W D Callister Jr, Materials Science and Engineering, Wiley, 2006
V Raghavan, Materials Science and Engineering, Prentice Hall of. India Private Limited, New Delhi, 1990, 3rd Edition

MT301N METAL CASTING & JOINING OF MATERIALS (2-0-2) 3

Sand-Moulding and Casting Practice: pattern-making, foundry sand & tools, sand-moulding. Foundry Mechanization: Layout, moulding machines, furnaces, melting & pouring practices. Industrial moulding & casting methods: CO_2 process, lost-wax process, plaster of Paris moulding, shell moulding, centrifugal casting, die-casting. Gating Design: gating elements & types, Chvorinove's rule, Bernoulli's principle, law of continuity, design of feeding and gating system. Numerical problems in gating system design, casting defects. Metallurgy of cast-iron & cast-alloys: solidification of ingots and castings, metallurgy of cast iron, cast-alloys of aluminium, copper, and nickel. Lab Practice: sand-testing, green-sand preparation, bench-moulding, and pouring practice.

Introduction to Joining of Metals: Welding, Brazing and Soldering. Gas-Welding: equipment, welding flame, gas-welding practice, gas-cutting. Shielded Metal Arc Welding: Principles, Equipment, Heat-input, welding patterns, welding-joints. Other Welding Practices: TIG/MIG, SAW, electron-beam welding, laser-welding, arc-cutting

Principles of metal casting, Hein and Rosenthal, McGrow Hill
Foundry engineering, Srinivasan, Khanna

MT302N MANUFACTURING PROCESSES: POWDER METALLURGY & METAL FORMING (2-1-0) 3

Historical Development of Powder Metallurgy, Reasons for Using Powder Metallurgy, Advantages of Powder Metallurgy (P/M), Limitations, Applications. Metal Powder Production Methods, Production of Ceramic Powders, Microstructure Control In Powders, Powder Treatments And Handling, Pyrophoricity and Toxicity of Metal Powders, Powder Characteristics, Consolidation of Metal and Ceramic Powders, Classification of P/M Parts, Compaction Characterization. Sintering, Types of Sintering, Sintering Theory, Sintering Mechanisms, Solid State Sintering, Sintering of Multicomponent Systems, Sintering Variables, Effects of Sintering, Sintering Atmospheres and Equipment, Metallography of P/M Parts, Postsintering Operations. Testing, P/M Products: Porous P/M Parts, Sintered Carbides, Cermets, Sintered Friction Materials, Refractory Metals, Cemented Carbides or Hard Metals, Dispersion Strengthened Materials, Electrical Applications of P/M, Magnetic Materials, Structural P/M Parts; Mechanical Alloying, Metal Injection Molding (MIM) Testing, Standards and Quality Controls. Metal Additive Manufacturing / 3D printing: An introduction. Fundamentals of Plasticity: Concepts of stress and strain and flow curves. Introduction to Bulk Deformation Processes. Rolling: Types of rolling mills, roll pressure, and defects. Forging: Open and closed die forging, forging loads, and equipment. Extrusion and Drawing: Wire, rod, and tube drawing; hot and cold extrusion processes.

Sheet Metal Working: Shearing, bending, deep drawing, and forming limit diagrams. Deep drawing, and forming limit diagrams. Mechanics and Defects: Evaluation of forces, power requirements, and common defects in formed parts.

Powder Metallurgy- Science, Technology and Applications, 3rd Edition, P. C. Angelo and R. Subramanian, PHI Learning Private Limited, Delhi, 2012.
Powder Metallurgy- Advanced technique of processing engineering materials, 2nd Edition, B. K. Dutta, PHI Learning Private Limited, Delhi, 2014.
Powder Metallurgy Science, 2nd edition, Randall M. German, Metal Powder Industries Federation, USA, 1994.
An Introduction to Powder Metallurgy, F. Thummler and R. Oberacker, The Institute of Materials, 1993.
G E Dieter, Mechanical Metallurgy, Tata McGraw-Hill, 2013, Indian Edition

MT303N CORROSION ENGINEERING (2-0-2) 3

Fundamentals of corrosion, Corrosion thermodynamic, Electrode double layer, Corrosive environments, corrosion failure (case study), corrosion cost. Electrochemical Aspects, Corrosion kinetics, Mixed Potential Theory, role of cathodic reactions, area effects, Polarization effects, Effect of Galvanic Coupling Using Mixed Potential Theory Passivity theory, active-passive transition plots, Environmental Effects, Effect of Oxygen and Oxidizers, Effect of Temperature, Effects of Corrosive Concentration, Details of type of corrosion: uniform, Galvanic, Pitting, Crevice, Sensitization, Intergranular corrosion (IGC), Details of type of corrosion: SCC, role of strain rate, role of allying elements and electrochemical corrosion, Tribocorrosion, Microbial Corrosion etc.

Corrosion mitigation: Materials Selection, Alteration of Environment, Design, Cathodic and Anodic Protection, Coatings, inhibitors, and corrosion managements. High temperature Oxidation and Hot corrosion: high-temperature oxidation, Thermodynamics of oxidation, Ellingham diagrams: concept, interpretation, and applications, Kinetics of oxidation: parabolic, linear, logarithmic, and other rate laws. Hot Corrosion: significance in gas turbines, boilers, and marine environments, type of hot corrosion (Type I & Type II), Role of molten salts (Na_2SO_4, NaCl, V_2O_5, etc.) Prevention & Control Methods: Alloy design and selection, Overlay coatings (MCrAlY) and Thermal barrier coatings (TBCs). Corrosion Standard: ASTM and NACE Standard for Corrosion examinations. Weight loss measurement, Salt spray test DC Corrosion measurement (Tafel extrapolation, Linear polarization, Potentiodynamic test, cyclic polarization, Cyclic Voltammetry, AC corrosion test: Electrochemical impedance spectroscopy for the corrosion, coating and inhibitor examinations and Interpretation of Results.

Mars G. Fontana, Corrosion Engineering, 3rd edition, McGraw-Hill Book Company, 1986
David Talbot and James Talbot, Corrosion Science and Technology, CRC Press, New York, 1998
H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985)
K.E. Perumal and V.S. Raja, Corrosion Failures: Theory, Case Studies, and Solutions" 1st edition, John Wiley & Sons, USA
ASTM and NACE standards for corrosion testing

MT304N COMPUTATIONAL MATERIALS SCIENCE (1-1-2) 3

Introduction to Computational Materials Science. Lab 1: Overview of various software. Interatomic potentials; LJ, EAM, Tersoff, Buckingham: Lab 2: Overview of various software. MD algorithms—integrators, ensembles, thermostats, barostats: Lab 3: LAMMPS. Practical MD using ROMACS—system setup, input files: Lab 3: Avagedro & Auto Dock. Post-processing—RDF, MSD, diffusion, mechanical properties Lab 5: GROMAC. Quantum mechanics foundations and Kohn-Sham DFT. Lab 6: GROMAC. Pseudopotentials, XC functionals, plane-wave basis: Lab 7: GROMAC. Practical DFT using Quantum ESPRESSO—SCF, NSCF, convergence Lab 8 : DFT. Band structure, DOS, geometry optimization Lab 9 : DFT Energetics, charge density, materials property predictions Lab 10: DFT Advanced DFT applications: total energy calculations, defect formation energy Lab 11: DFT Beyond standard DFT: limitations of DFT and introduction to DFT+U Lab: 12: DFT

Understanding Molecular Simulation – D. Frenkel & B. Smit APess 2002
Density Functional Theory: A Practical Introduction by David S. Sholl and Janice A. Steckel 2009 John Wiley & Sons, Inc.

Machine Learning in 2D Material Science by Parvathi Chundi, Venkataramana Gadhamshetty, Bharat K. Jasthi,Carol Lushbough CRC Press 2023
Allen, Michael P. & Tildesley, Dominic J. (2nd edn, 2017). Computer Simulation of Liquids Oxford University Press
Parr, Robert G. & Yang, Weitao (1995). Density-Functional Theory of Atoms and Molecules. Oxford University Press Sandfeld, Stefan (2024).
Materials Data Science: Introduction to Data Mining, Machine Learning, and Data-Driven Predictions for Materials Science and Engineering. Springer
Computer-Aided Drug Design – IIT Madras – NPTL/ SWAYAM
Computational Quantum Chemistry – IIT Bombay NPTL/ SWAYAM
Introduction to machine learning NPTEL Prof. S. Sarkar IIT Kharagpur

MT350N FATIGUE, FRACTURE AND CREEP (3-0-0) 3

Machine design concepts, factor of safety, stress concentration factor, tress intensity factor, fracture toughness, theories of Inglis, Griffith and Irwin, numerical problems, Classification of fracture, fracture signature identification, fractography, characterization tools, failure analysis, case studies, Introduction to fatigue failure, s-n curves, generation of S-N curves, statistical variations, low cycle fatigue, high cycle fatigue, Goodman diagram, case studies, Introduction to creep, creep curves, creep test, creep-rupture test, stress-rupture test, deformation mechanism maps

G E Dieter, Mechanical Metallurgy, Tata McGraw-Hill, 2013, Indian Edition
W D Callister Jr, Materials Science and Engineering, Wiley, 2006

MT351N EXTRACTION OF NON-FERROUS METALS (3-0-0) 3

Basics of Extractive metallurgy, Extraction of metals from oxide sources, Basic approaches, and special features of specific extraction processes, refining of metals; Extraction of Aluminium: type of aluminium minerals, Bayer Process (European and American), Hall-Heroult Process, Industrial practice in India (Refinery and smelter units) Hoopes' three-layer process, ALCOA, and ALCAN process of Al production; Extraction of metals from sulphides ore sources (Pyro-metallurgy and hydrometallurgy) Production of copper, zinc (conventional and advanced routes); A brief extraction process of gold, titanium, Zirconium and Uranium

H S Ray, R Sridhar and K P Abraham, Extraction of nonferrous metals, Affiliated East West Press Pvt Ltd., New Delhi, 2007
F Habashi, Principles of Extractive Metallurgy, Vol.1-4, Gordon and Breach, New York
T Rosenqvist, Principles of Extractive Metallurgy, McGraw Hill, New York, 1983
R D Pehlke, Unit processed in extractive metallurgy, Elsevier, Amsterdam, 1982
H S Ray and A Ghosh, Principles of extractive metallurgy, Wiley Eastern Ltd., New Delhi, 1991
S K Dutta, D R Lodhari, Extraction of Nuclear and Non-ferrous Metals; Topics in Mining, Metallurgy and Materials Engineering; Series Editor: Carlos P Bergmann; Springer, ISBN 978-981-10-5172-2 (eBook) 2021
Ministry of Mines reports (Indian)
Research Publications (Technical and review articles): Elsevier and Springers publications
Production data from Open sources

MT352N SECONDARY REFINING OF STEELS (3-0-0) 3

Introduction to secondary steel making. Fundamentals: Thermodynamics, chemical kinetics, fluid flow, heat transfer and mass transfer. Deoxidation of steel: Precipitation and diffusion deoxidation. Decarburization and desulphurization of liquid steel. Inert gas purging. Injection ladle metallurgy: powder injection and wire injection. Inclusions and inclusion removal from liquid steel. Vacuum degassing processes: Ladle degassing (Vacuum degassing and vacuum arc degassing), stream degassing and circulation degassing (RH and DH). Refining by remelting: Vacuum arc remelting (VAR) and electroslag remelting (ESR). Stainless steel making:

Thermodynamics, duplex and triplex process, argon oxygen decarburization (AOD) and vacuum oxygen decarburization (VOD) processes. Clean steel technology. Mass and heat balance calculations.

Ahindra Ghosh, Secondary Steelmaking: Principles and Applications, CRC Press, 2000
A Ghosh and A Chatterjee, Ironmaking and Steelmaking: Theory and Practice, Prentice Hall of India, 2008

MT353N PROCESS PLANT MATERIALS (3-0-0) 3

Selection of process materials, fabrication, mechanical properties and strength of materials, effect of temperature on mechanical properties, testing and inspection of materials, properties and uses of ferrous metals, cast iron, plain carbon steels, thermal and electrical insulating materials, non- ferrous metals and alloys, general properties and fields of application of non-ferrous metals, plastics as materials of construction for chemical plant, corrosion resistance, uniform corrosion, galvanic corrosion, pitting, intergranular corrosion, effect of stress, erosion corrosion, high temperature oxidation, hydrogen embrittlement, selection for corrosion resistance, corrosion charts, design for corrosion resistance

William F Smith, Principles of Material Science and Engineering, McGraw Hill Book Co,1990
Vernon John, Engg Materials, Macmillan, 1992, 3rd ed
W D Callister Jr, Materials Science and Engineering, Wiley, 2006

MT354N FUELS AND FURNACES (3-0-0) 3

Introduction: Classification of fuels, properties and tests; Types of fuels: Coal origins; carbonization and gasification; Other solid fuels; Liquid fuels - types, testing, properties; Gaseous fuels; Hydrates; Introduction to nuclear fuels; Alternate fuels; Combustion: Heat balance; principles of theory of combustion; combustion calculations; evolution of heat; flame temperature; waste heat utilization; Temperature measurement: Basic concept of temperature measurement and control; Thermocouples: principle, calibration, types and

Advantages; Furnaces: Classification of furnaces; Construction and working principles of furnaces like Cupola, Induction furnace, Microwave furnace, Spark Plasma Sintering furnaces, Arc furnace, Resistance furnace, Pit furnace, Rotary furnace, Muffle furnace etc. Designing of laboratory furnaces

O P Gupta, Elements of fuels, furnaces and refractories, Khanna Publishers, India, 2011, 6th ed
R C Gupta, Fuels, Furnaces and Refractories, PHI, India, 2016, 1st ed
O V Roussak and H D Gesser, Applied Chemistry: A Textbook for Engineers and Technologists, Springer-Verlag, USA, 2016, 2nd ed
G T Austin, Shreve's Chemical Process Industries, McGraw Hill, India, 2017, 5th ed
E S Gyngell, Applied Chemistry for Engineers, Arnold, UK, 1960, 3rd ed
S Agarwal, Engineering Chemistry Fundamentals and Applications, Cambridge University Press, India, 2019, 2nd ed
Y A Cengel, R M A Boles, M Kanogiu, Ch.15, Thermodynamics: an engineering approach, McGraw Hill, India, 2019, 9th ed

MT355N MACHINE DESIGN (3-0-0) 3

Fundamentals: Hooke's law, Elastic constants, Shear force and bending moment diagram, Bending equation, Beam deflection, Compound stress and Mohr's circle, working stresses, modes of mechanical failure, theories of failure, stress concentration, factor of safety, fatigue, Soderberg equation, members subjected to steady and alternating loads. Fits and tolerances; Design of Shafts and Keys, ASME design of transmission shafts, keys, design of square and rectangular key joints; Design of Welded and riveted Joints Welded and riveted joints, modes of failure, strength and efficiency of the joint; Design of Springs Stresses in coil springs of round and square c/s, deflection of coil springs, design of compression and tension springs; Design of Flexible Machine Elements; Flat belt, V belt drives rope drives; Design of Gears

Gears: Spur, Helical, Bevel, Worm gear, nomenclature, Lewis equation, Lewis form factor, design based

R L Norton, Machine Design, An integrated approach, Pearson Education Asia, 2000
Joseph Edward Shigley, Charles R. Mischke, Richard Gordon Budynas, Mechanical Engineering Design, Tata McGraw Hill, 2003
Allen Strickland Hall, Alfred R Holowenko, Herman G Laughlin, Machine Design, Schaum's Outline Series
V L Maleev and Hartman, Machine Design; CBS Pbl. New Delhi
Robert L Mott, Machine Elements in Mechanical Design, Pearson Prentice Hall 4th Edition
V B Bhandary, Design of Machine Elements, Tata McGraw Hill
Arthur G Erdman, George N, Sandor, Mechanism Design –Analysis, Vol-I, Prentice Hall, New
K Mahadevan and K Balaveera Reddy, Design data Hand Book, (SI Units) KREC- Surathkal
K Lingaiah, Design data Hand Book, (SI Units), Suma Pbl, Bangalore

MT356N MODELLING AND SIMULATION IN MATERIALS PROCESSES (3-0-0) 3

Introduction to modelling and simulation in materials processes. Introduction to transport phenomena in materials processing: Momentum, energy, and mass transport. Fundamental conservation laws: Newton's law of viscosity, Fourier's law of heat conduction, Fick's law of diffusion. Classification of Partial Differential Equations (PDEs): Elliptic, parabolic and hyperbolic. Classification of discretization methods: Finite difference, finite volume and finite element. Introduction to numerical errors. Classification of boundary conditions. Introduction to linear algebra: Direct and Iterative methods. Introduction to Phase-Field modelling. Applications of fluid flow, heat transfer and mass transfer in process metallurgy, casting, heat treatment, welding, manufacturing and other material processes. Programming using Python or MATLAB. Introduction to relevant simulation software

D R Poirier and G H Geiger, Transport Phenomena in Materials Processing, Springer, 2016, 1st ed
S C Chapra and R P Canale, Numerical Methods for Engineers, McGraw Hill, 2006, 5th ed
Fausett L V, Applied Numerical Analysis Using MATLAB, Pearson Education, 2007, 2nd ed
John D Anderson, Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, 1995
H K Versteeg and W Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson Education Limited, 2007, 2nd ed
S B Biner, Programming Phase-Field Modelling, Springer, 2017

MT400N NUCLEAR MATERIALS (3-0-0) 3

Structure of a nuclear power plant, requirements of reactor materials, fuel materials, plutonium uranium and thorium and their alloys and compounds, core materials: beryllium, graphite, control and shielding materials, magnesium and its alloys, aluminium and its alloys, zirconium and its alloys, austenitic stainless steel; materials for reactor vessel and other components, pearlitic steels, ferritic, chromium stainless steels, copper alloys, titanium and its alloys, coolants used in reactors: radiation embrittlement, corrosion of reactor materials, mechanical properties of materials.

V Gerasimov and A Monakhov, Nuclear Engineering Materials, Mir Publishers, Moskow, 1983
D S Clark and W R Varney, Physical Metallurgy for engineers, East West Press, New Delhi, 1987
C M Srivastava and C Srinivasan, Science of engineering Materials, 1997, New Age International

MT401N COMPOSITE MATERIALS (3-0-0) 3

Reinforcements, whiskers, matrix materials, polymers, metals, ceramics, interfaces: wettability, crystallographic nature, interactions, types of bonding: processing, thermoset matrix composites, thermoplastic matrix composites, structure and properties, structural defects, mechanical properties applications, processing: liquid-state processes, solid state processes, properties, thermal characteristics, aging, fatigue and creep applications, electronic-grade MMCs, ceramic matrix composites: processing, infiltration, directed oxidation properties, toughness, thermal shock resistance, applications- cutting tool inserts, ceramic composite filters.

K K Chawla, Composite Materials, Springer, New York, 1998
P K Mallick, Composite Materials Technology: Process and Properties, Hanser, New York, 1990
D Hull and T W Clyne, An Introduction to Composite Materials, Cambridge University Press, 1996

MT402N SURFACE ENGINEERING (3-0-0) 3

Current status of surface engineering, fundamentals of electrode position, electroless plating, metallising, hard anodizing, carburizing, nitriding, carbonitriding, flame hardening, induction hardening, thermal evaporation, sputter coating, ion plating electron-beam surface treatments, electron- beam hardening, laser hardening, ion implantation, hardfacing processes: shielded metal arc welding, gas tungsten arc welding, gas metal arc welding, flux cored arc welding, submerged arc welding, plasma arc welding, oxyacetylene welding, furnace fusing, thermal spray processes.

Kenneth G Budinski, Surface Engineering for Wear Resistance, Prentice Hall, New Jersey, 1988
P K Datta and J S Burnell-Gray, Surface Engineering, Vol. I, II, and III, Royal Society of Chemistry; 1993
J S Burnell, -Gray and, P K Datta, Surface Engineering Casebook- Solutions to Corrosion and Wear- related Failures, Woodhead Pub., 1996

MT403N SUSTAINABLE METALLURGY (3-0-0) 3

Introduction to Sustainability, Definition and principles, relevance in metallurgical and materials domains, circular economy and resource efficiency, Examples from iron and steel- traditional and alternative routes, aluminium, copper, semiconductor and rare-earth metal industries. Examples to cover process from mining, smelting, refining, product manufacture, consumption and disposal. Assessing, energy, social, and environmental impacts, principles and practices.

Sustainable Metals Management; Eds: Armin Reller, Lucia Mancini, Publisher: Springer
Mohamed N Essa, Sustainable Industrial Design and Waste Management: Cradle-to-Cradle for Sustainable Development, Elsevier
Fathi Habashi and G B Haxel, Extractive Metallurgy of Rare Earths, 2nd ed
Circular Economy: Global Perspectives, Practices and Challenges, Eds: Miguel Brandão, David Lazarevic, Göran Finnveden
Green Metallurgy, Ed: Sujay Kumar Dutta, Springer
Frank Kreith and Susan Krumdieck, Principles of Sustainable Energy Systems, 3rd ed

MT404N NON-DESTRUCTIVE TESTING (3-0-0) 3

Ultrasonic Inspection: ultrasonic waves, variables, attenuation, inspection methods, pulse echo, transmission methods, inspection standards, standard reference blocks, practical applications. Radiographic Inspection: radiographic inspection principles, radiation sources, image quality, radiographic sensitivity, geometric unsharpness, image intensifiers, X-ray films, exposure, penetrameters, inspection standards, neutron radiography, gamma radiography. Other techniques: visual inspection, in situ metallography, dye penetrant inspection, magnetic particle inspection, eddy current method, acoustic emission method, holography, computed tomography.

Barry Hull and Vernon John, Non-destructive Testing, Macmillan, London, 1989, ELBS ed
R Halmshaw, Non-destructive Testing, Edward Arnold, London, 1991, 2nd ed
W J McGonnagle, Non-destructive testing, Gordon and Beach Science, New York, 1983

MT405N AEROSPACE MATERIALS (3-0-0) 3

Carbon-carbon composites, production, properties and applications, intermetallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminium, magnesium, titanium and nickel-based composites for engines, superalloys, aluminium alloys, magnesium alloys and titanium alloys, materials for plasma engines, intermetallic aluminides, ceramics and polymeric materials

H Buhl, Advanced Aerospace Materials, Springer Verlag, Berlin 1992
Balram Gupta et.al Aerospace Materials Vol 1, 2, 3, ARDB, S Chand and Co. 1996

MT406N THIN FILMS, COATINGS AND APPLICATIONS (3-0-0) 3

Need for miniaturization, Basics of thin film, Brief review of kinetic theory of adsorption, desorption, film growth: nucleation and growth kinetics. Vacuum science and technology, vacuum pumps, surface: role of substrate surface, substrate cleaning. Epitaxy, thin film growth control, physical vapor deposition (PVD) processes, evaporation: thermal and e-beam. Principles of glow discharge and various sputtering processes. Fundamentals of Chemical Vapor Deposition (CVD) processes. Pulsed laser deposition (PLD), other techniques: electro-deposition, spin coating, solgel, Langmuir Blodgett (LB) techniques, SILAR technique, Doctor blade technique, printing. Hard coating: physical, mechanical and protective properties, basic thin film thickness measurement, microstructural characterization of films/coating. Thin film devices: optoelectronic devices, photo-detectors, solar cells. Applications: high hardness, corrosion resistance, biocompatibility and high temperature stability.

Milton Ohring, Materials Science of Thin Films, Academic Press, 2001, 2nd ed
Hartmut Frey and Hamid R Khan, Handbook of Thin Film Technology, Springer,2016
K L Chopra and L K Malhotra, Thin film Technology and Application, Tata McGraw-Hill, 1985
Peter M Martin, Handbook of Deposition Technologies for Films and Coatings, Elsevier, 1994
Sam Zhang, Nanostructured Thin Films and Coating, CRC Press, 2010
Narendra B Dahotre and T S Sudarshan, Intermetallic and Ceramics Coatings, Mercel Dekker Inc., 1999
L Tushinsky, I Kovensky, A Plokhov, V Sindeyev, P Reshedko, Coated Metal, Springer, 2002

MT450N SCIENCE AND TECHNOLOGY OF NANOMATERIALS (3-0-0) 3

Introduction: Definitions; classification; fundamental principles; nanoclusters; nanowires; nanotubes; nanolayers; nanopores; supramolecules; Synthesis: Top-down and bottom-up approaches; Plasma arcing; CVD; PVD ; Electro-deposition; Sol-gel synthesis; High energy ball milling; Nanolithography; Self-assembly; Langmuir-Blodgett films; Electrospinning; Properties: Size dependence of properties, such as: Electrical, Physical, Optical, and Chemical; Characterization: Particle size and surface area determination; Spectroscopy: IR and Raman spectroscopy, X-ray photoelectron spectroscopy; Microscopy: scanning tunnelling microscopy, transmission electron microscopy, field emission scanning electron microscopy, atomic force microscopy; Applications: Nanomachines and nanodevices; Nanocomposites: MMC, CMC and PMC; Impact of nanomaterials in the areas of materials manufacturing, health care, data storage, clean energy, etc; Society and nanotechnology: Challenges and fears; Impact on health and environment

D L Schodek, P Ferreira and M F Ashby, Nanomaterials, Nanotechnologies and Design, Butterworth-Heinemann, UK, 2009, 1st ed
G Cao, Y Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Imperial College Press, UK, 2004, 1st ed
M Wilson, K Kannangara, G Smith, M Simmons and B Raguse, Nanotechnology: basic science and emerging technologies, Chapman andamp; Hall, USA, 2004, 1st ed
M S Johal, L E Johnson, Understanding Nanomaterials, CRC Press, USA, 2018, 2nd ed
N O Petersen, Foundations for Nanoscience and Nanotechnology, Apple Academic Press, UK, 2017, 1st ed
Journal papers as recommended from time to time

MT451N ADVANCED MICROSCOPIC TECHNIQUES (3-0-0) 3

SEM - Review of electron optics, Electron specimen interactions, image formation and interpretation, High resolution imaging, WDS and EDS, Quantitative x-ray analysis, compositional mapping, Sample preparation for inorganic, organic, hydrated and biological materials. TEM-Review of electron optics, reciprocal space and electron diffraction, sample preparation, diffraction from crystals and small volumes, diffraction patterns and their indexing, Kikuchi diffraction, CBED, Amplitude contrast and phase contrast, Thickness and bending

effects, defects and their visualization, High resolution TEM, Quantitative analysis using TEM. Concept of EELS, STEM, XPS, Auger microscopy, SIMS, etc.

Joseph I Goldstein, Dale E Newbury, Joseph R Michael, Nicholas W M Ritchie, John Henr, J Scott, David C Joy, Scanning electron microscopy and X-ray analysis, Springer, 2018, 4th ed
D B Williams and C B Carter, Transmission electron microscopy, Springer, 2009
S Amelinckx, D van Dyck, J van Landuyt, G. van Tendeloo, Electron Microscopy: Principles and Fundamentals, VCH Verlagsgesellschaft mbH, 1997; Online ISBN:9783527614561

MT452N SMART MATERIALS AND SENSORS (3-0-0) 3

Inorganic: solid electrolyte sensor, oxygen sensors, hydrogen sensors, sulfur and sulfur containing gas sensors, humidity sensors, gas sensitive resistors, surface acoustic wave sensors, catalytic gas detectors, semiconductor junction devices, organic: semiconductor gas sensors, surface Plasmon resonance sensors, mass-sensitive sensors optical chemical sensors, electro chemical sensors, future prospects, automotive sensors: ceramic sensors, silicon sensors, chemical sensors for hostile environments, Piezoelectric sensors, actuator materials, micromechanics, chiral materials, conducting and chiral polymers, electrochromic materials, liquid crystals, molecular level smart materials, bio materials, composites, ceramics processing and fabrication, interface science, optical fibers, optical mirrors, smart skins for drag and turbulence control, other applications in aerospace/hydrospace structures, transportation vehicles, manufacturing equipment

Journal of Smart Materials and Structures, Back volumes, Institute of Physics, Polishing Bristol, UK
L Dai, Intelligent Macromolecules for Smart Devices, Springer, 2002

MT453N ADVANCED WELDING TECHNOLOGY (3-0-0) 3

Arc Characteristics: Cathode Spot, Cathode Drop Zone, Arc Column; Arc Efficiency; Arc Blow; Types of Welding Arcs, Arc Initiation; Arc Maintenance, Electrode Polarity, Arc Stability, Arc Temperature, Metal Transfer, Power Sources for Resistance Welding, Fusion Welding Process Variables, Gases in Weld Metal, Weld Thermal Cycle, Heat flow in welding - Significance, Theory of Heat Flow, Cooling Rate Determination, Heat Flow Equations, Characteristics of Weld Solidification, Thermal Gradients and Turbulence in the Melt, Geometry of Weld Melt, Epitaxial Solidification, Cellular and Dendritic Solidification in Welds, Refining of Weld Structure, Phase Transformation During Weld Metal Cooling, Heat Affected Zone, Carbon Equivalent, Heating Cycle, Recrystallization, Phase Transformation, Precipitate Stability, Coarsening, Dissolution During Weld Thermal Cycle, Grain Growth; Reactions at The Fusion Line, Hardness Measurements, Multi Run Welds, Cracking and Fracture in Welds, Special Welding Techniques: Electron Beam Welding, Laser Welding, Ultrasonic Welding, Numerical Problems in Welding, Residual Stresses in Welds and Their Measurements, Weld Defects, Use of Schaeffler Diagram, Weldability Tests, Weldability of Plain Carbon Steels, Low Alloy Steels, Stainless Steels, Tool Steels, Cast Iron

R S Parmer, Welding Processes and Technology, Khanna Publishers, 2015, 3rd ed
L M Gourd, Principles of welding technology, Viva Books Private Limited, India, 2004, 1st ed
Ibrahim Khan, Welding Science and Technology, New Age International Publishers, India, 2009
J F Lancaster, Metallurgy of welding, Woodhead Publishing Limited, Cambridge, London, 1999, 6th ed
Kenneth Easterling, Butterworth Heinemann, Introduction to the Physical Metallurgy of Welding, 2nd Edition1992
Welding and Welding Technology, Richard L. Little, Tata McGraw Hill, 2004

MT454N ADVANCED ENGINEERING MATERIALS (3-0-0) 3

Metals for high temperature service, Ti and Zr alloys, Ni and Co based super alloys, rapid solidification, metallic glasses, production, properties and applications, liquid crystals: production, properties and applications, composite materials, mechanics of composite materials, dispersion strengthening, metal matrix composites,

special steels, maraging steels, trip steels, interstitial free steels, smart materials, shape memory effect, principles, pseudoelasticity, applications, nano technology, nano materials.

R E Reed - Hill, Lara Abbaschian, Raza Abbaschian, Physical Metallurgy Principles, Cengage, 2013, 4th ed
W E Smith Structure and Properties of Engineering Alloys McGraw Hill, 1993
F L Matthews and R. D. Rawlings, Composite Materials Engg. and Science, 1994
K K Chawla, Composite Materials, 2nd Edition, Springer - Verlag 2001

MT455N RECYCLING AND CIRCULAR ECONOMY (3-0-0) 3

Introduction to recycling of materials. Recycling of metallic scrap, waste electrical and electronic equipment (WEEE), waste plastics, ceramics, and composites. Recycling techniques for essential energy materials, including batteries, solar cells, and fuel cells. Recycling of industrial and municipal wastes. Introduction to techno-economic analysis and Life Cycle Analysis (LCA). Environment impact assessment of products through LCA analysis. Introduction to circular economy. Design and implementation of circular systems for various industries, with a focus on Environmental, Social, and Governance (ESG) factors. Global and Indian policies and business models. Case studies and emerging trends in material recycling and circular economy.

Handbook of Recycling: State-of-the-art for Practitioners, Analysts, and Scientists, Eds Christina Meskers, Ernst Worrell, Markus A Reuter, Elsevier, 2023, 2nd ed
Materials Recycling, Ed: Abel Hall, Larsen and Keller Education, 2017
Life Cycle Assessment: Theory and Practice, Eds: Michael Z Hauschild, Stig Irving Olsen, Ralph K Rosenbaum, Springer, 2017
Handbook of Materials Circular Economy, Seeram Ramakrishna, Brindha Ramasubramanian, Springer, 2024
Circular Economy and Sustainable Energy Materials: A Net-Zero Emissions Approach, Eds: Ngoc Thanh Thuy Tran, Wei-Sheng Chen, Shou-Heng Liu, Jow-Lay Huang, CRC Press, 2025, 1st ed

MT456N BIO-MATERIALS (3-0-0) 3

Introduction to biomaterials, structure and properties of proteins and cells, different properties/characteristics of biomaterials (in vitro and in vivo), cell-material Interaction, surface engineering of biomaterials, structure-property relationship of various biomaterials, characterization of different biomaterial morphologies, fabrication techniques for different types of biomaterials substrates (metals, ceramics, polymers and composites), designing biomaterials formulations for various medical applications including wound dressing, drug delivery, bone regeneration, vascular tissue engineering, biosensors, and flexible electronics

A Sandeep Kranthi Kiran and Seeram Ramakrishna, An Introduction to Biomaterials Science and Engineering. 2021, World Scientific
Buddy D Ratner, Allan S Hoffman, Frederick J. Schoen, and Jack E Lemons, Biomaterials science: an introduction to materials in medicine. 2004, Elsevier, 2nd ed
William R Wagner, Shelly E Sakiyama-Elbert, Guiren Zhang and Michael J Yaszemski., Biomaterials Science - An Introduction to Materials in Medicine, 2021, Elsevier, 4th ed

MT398N/ MT448N/ MT498N INTERNSHIP – I/ II/ III (0-0-18) 9

Internship is an integral component of the B.Tech. curriculum intended to provide students with practical exposure and an opportunity to apply their academic knowledge in real-world engineering, research, and professional environments. Students may undertake internships in industry, R&D organizations, academic/research institutions, or other organizations approved by the Institute. Internships outside NITK shall require prior approval of the concerned Department. Of the three Internship/Major Project slots available during the sixth to eighth semesters, a student may undertake the Internship/Major Project outside NITK for a maximum of two semesters. The internship shall be carried out under the guidance of a faculty member of the Institute and an industry/research mentor and shall be evaluated based on the work undertaken, report, presentation, and other criteria prescribed by the DUGC of the respective Department.

MT399N	**MAJOR PROJECT - I**	**(0-0-18) 9**
MT449N	**MAJOR PROJECT - II**	**(0-0-18) 9**
MT499N	**MAJOR PROJECT - III**	**(0-0-18) 9**

Department of Design and Entrepreneurship

DE221N CONTEMPORARY ENTREPRENEURSHIP (3-1-0) 4

Self Discovery; Opportunity discovery, Customer and Solution – understanding who is the customer, identify job, pains, gains and early adopters, Establish your venture's unique value proposition and competitive advantage; Basics of business models and lean canvas; Validation – refine value proposition with blue ocean strategy, build solution demo, prototype development; Understanding cost structures, bootstrapping and initial financing Positioning and branding, Sales plan using funnel approach; Support – Project management, operating a business. Pivoting – evaluating different business models, analyze competitors, product management. Business planning – yearly sales, people and financial plan; Growth strategy – scaling customers, revenue and sources of funding; Team building; Brading and channel strategy – Understand and examine different channels; Leveraging technology – Identifying technology needs and choosing key technologies, technology as a competitive advantage; Measuring progress establishing key metrics and measuring; Legal – Incorporating, regulations.

School of Humanities, Social Science and Management

The Syllabus for electives offered by the School of Humanities, Social Sciences and Management may be referred from the MBA curriculum.

MINOR PROGRAMMES

Minor in Civil Engineering

CE201MN	Elements of Surveying	(3-0-0) 3
CE250MN	Highway and Traffic Engineering	(3-0-0) 3
CE251MN	Soil Mechanics	(3-0-0) 3
CE254MN	Environmental Engineering	(3-0-0) 3
CE301MN	Estimation, Costing and Specifications	(3-0-0) 3

Minor in Computational and Data Science
(Except for CS, IT, AI, EC Programmes)

MA280MN	Applied Linear Algebra	(3-0-0) 3
MA330MN	Optimization for Machine Learning	(3-0-0) 3
MA380MN	Probability and Statistics	(3-0-0) 3
MA430MN	Foundations of Machine Learning	(2-1-0) 3
MA480MN	Deep Learning and Applications	(2-1-0) 3

Minor in Computer Science and Engineering
(Except for IT/AI/DS Programme)

CS202MN	Data Structures and Algorithms	(3-0-0) 3
CS251MN	Database Systems	(3-0-0) 3
CS252MN	Operating Systems	(3-0-0) 3
CS300MN	Machine Learning	(3-0-0) 3
CS301MN	Computer Networks	(3-0-0) 3

Minor in Economics

SM205MN	Microeconomics	(3-0-0) 3
SM255MN	Macroeconomics	(3-0-0) 3
SM310MN	Introduction to Industrial Economics and Organization	(3-0-0) 3
SM355MN	Financial Economics	(3-0-0) 3
SM410MN	Development Economics	(3-0-0) 3

Minor in Electrical and Electronics Engineering

EE271MN	Electric Circuits	(2-1-0) 3
EE371MN	Basic Electric Machines	(2-1-0) 3
EE372MN	Electric Power System	(2-1-0) 3
EE471MN	Electrical and Electronics Measuring Instruments and Techniques	(2-1-0) 3
EE472MN	Power Electronics in Power Control	(2-1-0) 3

Minor in Electronics and Communication Engineering

EC307MN	Digital Electronics	(3-0-0) 3
EC308MN	Signals and Systems	(3-0-0) 3
EC309MN	Data Communication and Networks	(3-0-0) 3
EC372MN	Analog Electronic Circuits	(3-0-0) 3
EC373MN	Communication Systems	(3-0-0) 3

Minor in Information Technology

IT200MN	Object Oriented Programming	(2-0-2) 3
IT204MN	Data Structures	(2-0-2) 3
IT250MN	Design and Analysis of Algorithms	(2-0-2) 3
IT251MN	Database Systems	(2-0-2) 3
IT304MN	Web Technologies and Applications	(2-0-2) 3

Minor in Management

SM200MN	Financial Management	(3-0-0) 3
SM250MN	Human Resource Management	(3-0-0) 3
SM305MN	Business Analytics and Decision Making	(3-0-0) 3
SM350MN	Entrepreneurship	(3-0-0) 3
SM405MN	Marketing Management	(3-0-0) 3

Minor in Mechanical Engineering

ME501MN	Manufacturing Engineering	(3-0-0) 3
ME502MN	Thermal Engineering	(3-0-0) 3
ME503MN	Mechanical Design	(3-0-0) 3
ME504MN	Production Management	(3-0-0) 3
ME505MN	Industrial Automation	(3-0-0) 3

Minor in Metallurgical and Materials Engineering

MT200MN	Physical Metallurgy	(2-1-0) 3
MT202MN	Extractive Metallurgy	(2-0-2) 3
MT203MN	Ceramics and Refractories	(2-0-2) 3
MT204MN	Polymer Science and Technology	(2-0-2) 3
MT252MN	Phase Diagrams and Phase Transformations	(2-1-0) 3

Minor in Mining Engineering

MN480MN	Mining Technology	(2-1-0) 3
MN481MN	Rock Excavation Engineering	(2-1-0) 3
MN482MN	Mine Safety Engineering	(2-1-0) 3
MN483MN	Mine Mechanization	(2-1-0) 3
MN484MN	Environmental Management	(2-1-0) 3

Minor in NADAL

NA201MN	Introduction to Defence, Adventure and Leadership	(2-0-2) 3
NA202MN	Self-Defence and Wilderness Survival	(2-0-2) 3
NA301MN	Strategic Leadership and Team Management	(2-0-2) 3
NA302MN	Mountaineering and Water Sports	(2-0-2) 3
NA401MN	Leadership in the Armed Forces	(2-0-2) 3

Minor in Physics

PH701	Mathematical Methods – I	(3-1-0) 4
PH702	Classical Mechanics	(3-1-0) 4
PH703	Quantum Mechanics – I	(3-1-0) 4
PH752	Quantum Mechanics – II	(3-1-0) 4
PH754	Electromagnetic Theory	(3-1-0) 4

INTERDISCIPLINARY MINOR

Minor in Machine Learning
(Except for AI Students)

Common Courses

MA212MN	Mathematics for Machine Learning	(4-0-0) 4
MA309MN	Mathematical Foundations of Data Science	(3-1-0) 4

IT340MN	Machine Learning	(3-0-2) 4
CS422MN	Deep Learning	(3-1-0) 4

Parent Department Specific Courses

Chemical Engineering

CH459MN	Machine Learning Applications in Chemical Engineering	(0-0-6) 4

Civil Engineering

CV448MN	Machine Learning Applications in Civil Engineering	(0-0-6) 4

Computer Science and Engineering

CS367MN	Foundations of CPS	(3-1-0) 4
CS426MN	Reinforcement Learning	(3-1-0) 4
CS473MN	Project for ML Minors	(0-0-6) 4

Electrical and Electronics Engineering

EE450MN	Applications of Machine Learning Techniques to Problems in Electrical Engineering	(3-0-2) 4

Electronics and Communication Engineering

EC500MN	Machine Learning for Electronics and Communication Engineering	(3-1-0) 4

Information technology

IT479MN	Machine Learning Minor Project	(0-0-6) 4

Mechanical Engineering

ME496MN	Application Project in Mechanical Engineering	(0-0-6) 4

Metallurgical and Materials Engineering

MT494MN	Project for Machine Learning Minor	(0-0-6) 4

Mining Engineering

MI485MN	Project for Machine Learning Minor	(0-0-6) 4

Suggested Plan of Study:

Sem III	Sem IV	Sem V	Sem VI	Sem VII
MA212MN	MA309MN	IT340MN	CS422MN	Parent Department Specific Course

Minor in Civil Engineering

CE201MN ELEMENTS OF SURVEYING (3-0-0) 3

Introduction to Surveying - Basic concepts, Errors, accuracy and precision; Tape surveying; Compass surveying; Theodolite traverse - measurement of horizontal and vertical angles, traversing; Levelling; Contouring; Horizontal and Vertical curves; Electronic distance measurements; Total station; Areal photogrammetry, Remote sensing and GIS.

B. C. Punmia, Surveying Vol. I & II – Laxmi Publications, New Delhi.
K. R. Arora, Surveying Vol. I & II – Standard Book House, New Delhi.
S. K. Roy, Fundamentals of Surveying - Prentice Hall of India, New Delhi.

CE250MN HIGHWAY AND TRAFFIC ENGINEERING (3-0-0) 3

Highway Engineering – Introduction to highway engineering, road classification and highway development; Road Users – Characteristics, factors affecting road user behaviour; Vehicle Performance – Tractive effort, resistances, power and speed relationships; Highway Geometric Design – Introduction, design controls and criteria, Sight Distances, Horizontal Alignment, Vertical Alignment, Coordination of Horizontal and Vertical Alignment; Traffic Engineering – Introduction, Traffic Studies, Design of Intersections and Traffic Signals, Traffic Signs and Road Markings, Principles of Road Safety, Introduction to Smart Mobility; Pavement Engineering – Desirable Properties of Pavement Materials, Design of Flexible Pavements, Design of Rigid Pavements.

Khanna, S. K. and Justo, C. E. G. (2017), Highway Engineering, Nem Chand & Bros.
Kadiyali, L. R. (2013), Principles of Highway Engineering, Khanna Publishers.
Kadiyali, L. R. (2017), Traffic Engineering and Transport Planning, Khanna Publishers.
IRC:35-2015 – Code of Practice for Road Markings
IRC:37-2018 – Guidelines for the Design of Flexible Pavements
IRC:58-2015 – Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
IRC:67-2012 – Code of Practice for Road Signs
IRC:73-2023 – Geometric Design Standards for Non-Urban Roads
IRC:93-1985 – Guidelines on Design and Installation of Road Traffic Signals
IRC: SP:41-1994 – Guidelines for the Design of At-grade Intersections in Rural and Urban Areas
IRC: SP:73-2018 – Manual of Specifications and Standards for Two-Laning of Highways with Paved Shoulders
IRC: SP:84-2019 – Manual of Specifications and Standards for Four-Laning of Highways
IRC: SP:99-2013 – Manual of Specifications and Standards for Expressways
Pavement Materials (Prof. Nikhil Saboo, IIT Roorkee) https://onlinecourses.nptel.ac.in/noc22_ce93/preview
Traffic Engineering (Prof. Bhargab Maitra, IIT Kharagpur) https://onlinecourses.nptel.ac.in/noc24_ce35/preview

CE251MN SOIL MECHANICS (3-0-0) 3

Introduction, Origin, nature and distribution of soils. Clay mineralogy, Soil fabric and structure, three phase system, Index properties, Numerical examples. Soil classification- Indian Standard Classification System; Soil hydraulics, Darcy's Law, Determination of coefficient of permeability; Effect of flow on effective stress; Quick sand condition; Soil compaction- Moisture density relationship, Standard & Modified Proctor Tes; Pore water pressure, effective stress, total stress. Capillarity in soils, Stress distribution in soils; Consolidation – Primary and secondary consolidation, Spring analogy; Computation of settlement, Numerical examples; Terzaghi's theory, Determination of coefficient of consolidation, Numerical examples; Shear strength of soils- State of stress, Mohr Coloumb theory, Relation between shear strength parameters and principle stress. Shear strength measurement- Direct shear test, UCS, Triaxial compression test, vane shear test.

T.W. Lambe and R.V. Whitman "Soil Mechanics", John Wiley & Sons, New York

Gopal Ranjan and A.S.R. Rao "Basic and Applied Soil Mechanics", New Age International Pub.
Geotechnical Engineering Handbook by Braja M. Das
Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck and Gholamreza Mesri

CE254MN ENVIRONMENTAL ENGINEERING (3-0-0) 3

Essentials of water engineering systems; Water sources and demand; Water and wastewater quantities and characteristics, online BOD measurement; Water distribution systems, planning and analysis of water distribution systems, and the use of EPANET software for the quantitative and qualitative analysis of water supply networks; Drinking water standards, Central Public Health & Environmental Engineering Organisation (CPHEEO) manual for water supply and treatment, BIS guidelines; Unit operations and processes of water treatment; Design of a water treatment unit; Essentials of wastewater engineering systems; Wastewater collection and house drainage; Central Public Health & Environmental Engineering Organisation (CPHEEO) manual for wastewater treatment; Unit operations and processes of wastewater treatment, biological nutrient removal techniques (BNR); Design of wastewater treatment units; Consent for establishment and operation of STPs from the State pollution control department; Field visit and hands-on experience

H. S. Peavy, D. R. Rowe, G. Tchobanoglous, "Environmental Engineering", McGraw-Hill Publication
Fair & Geyer, "Water Supply and Waste Water Disposal", John Wiley Publications
B.C. Punmia & Ashok Jain, "Water Supply Engineering & Wastewater Engineering", Arihant Publications
CPHEEO Water Supply & Treatment Manual
CPHEEO Sewerage & Sewage Treatment Manual
BIS guidelines
Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts - https://onlinecourses.nptel.ac.in/noc26_ge27/preview (SWAYAM course)

CE301MN ESTIMATION COSTING AND SPECIFICATIONS (3-0-0) 3

Introduction to estimation, types of estimates, Measurements, taking out quantities by method of centreline. Taking out quantities by method of long walls and short walls. Typical estimates for residential buildings. Earthwork calculations including hillside roads. Introduction to departmental procedures. Types of contracts, termination, measurement book, and payment to contractors. Tenders, arbitration. Specifications, types and method of drafting. Detailed specifications for selected types of building items. Introduction to analysis of rates. Rate analysis for selected items of works. Introduction to valuation, purpose, forms of value, outgoings, valuation of existing buildings. Valuation of land.

B. N Dutta, "Estimation and Costing in Civil Engineering Theory and Practice", CBS Publishers and Distributors.
M. Chakroborti, "Estimation, Costing and Specifications in Civil Engineering".
S. C. Rangawala, "Valuation of Real Properties", Charotar Publishing House.

Minor in Computational and Data Science

(Except for CS, IT, AI, EC Programmes)

MA280MN APPLIED LINEAR ALGEBRA (3-0-0) 3

Scalars, vectors and matrices; linear independence, basis and dimension; Subspaces; row space, column space, null space; Inner products, orthogonality and projections; Gram-Schmidt orthogonalization; QR factorization. Orthogonal complements; rank and nullity; Determinants, Matrix inverse and systems of linear equations; Gaussian elimination; LU factorization; Least-squares problems and overdetermined systems. Eigenvalues and eigenvectors; Characteristic polynomial, Diagonalization; Symmetric matrices and spectral theorem; Positive definite and positive semidefinite matrices. Singular values and singular vectors; Singular value decomposition and applications.

G. Strang, Introduction to linear algebra. Wellesley-Cambridge Press, 2022.

S. H. Friedberg, A. J. Insel, L.E. Spence, Linear Algebra, 4th Edition, Pearson. 2015.
G. Strang, Linear Algebra and Learning from Data. Wellesley-Cambridge Press, 2019.
Deisenroth, M. P., Faisal, A. A., Ong, C. S., Mathematics for Machine Learning, Cambridge University Press, 2020.

MA330MN OPTIMIZATION FOR MACHINE LEARNING (3-0-0) 3

Introduction, Types of problems and existence of optimal solutions. Recap of Gradients, Directional derivatives, Normals to level curves and tangents, Extreme values and saddle points. Local and Global minimizers, Conditions for local minimizers, first and second order necessary conditions, Convex and concave Functions, Minimization and maximization of convex functions. Line search methods: Golden Section Search, Fibonacci Search, Newton's method, Secant method. The Method of steepest descent, Newton's method, Coordinate descent methods. Conjugate gradient methods, Quasi-Newton methods. Basic properties of linear programs, Simplex method. Nonlinear constrained optimization problems with equality and inequality constraints, KKT conditions.

D. G. Luenberger and Y. Ye, Linear and Nonlinear Programming, Springer, 4th Edition, 2016
Chong and Zak, An Introduction to Optimization, John Wiley & Sons, Third Edition, 2008
S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2009
J. Nocedal and S. J. Wright, Numerical Optimization, Springer, 2006

MA380MN PROBABILITY AND STATISTICS (3-0-0) 3

Sample spaces and events; Probability axioms; Conditional probability; Independence; Law of total probability; Bayes theorem; Counting techniques; Random experiments. Discrete and continuous random variables; PMF, PDF, and CDF; Expectation and variance; Moments; Covariance and correlation; Joint distributions; Marginal and conditional distributions; Functions of random variables. Bernoulli, Binomial, and Geometric distributions; Poisson distribution; Uniform distribution; Exponential distribution; Gaussian/Normal distribution; Gamma distributions; Multivariate Gaussian distribution; Covariance matrices; Conditional Gaussian distributions. Population and sample; Sampling distributions; Weak Law of Large Numbers; Central Limit Theorem; Point estimation; Properties of estimators; Bias and variance; Method of moments; Maximum likelihood estimation; Confidence intervals. Statistical hypotheses; Correlation and covariance;

S. M. Ross, Introduction to probability and statistics for engineers and scientists. Academic press, 2020.
R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, 5th Edition, McMillan, 1995.
D. C. Montgomery and G. C. Runger, Applied statistics and probability for engineers. John Wiley & sons, 2010. P L Meyer, Introductory Probability and Statistical Applications, Oxford and IBH.

MA430MN FOUNDATIONS OF MACHINE LEARNING (2-1-0) 3

Introduction to machine learning, motivations, applications, learning paradigms and strategies. Data representation feature scaling, bias–variance trade-off. Dimensionality reduction: PCA and Fisher's Linear Discriminant Analysis. Probabilistic learning: Bayesian classifier, linear and quadratic discriminant analysis. Optimization methods: gradient descent, stochastic and adaptive gradient techniques. Feature extraction and feature selection methods. Linear models: linear regression and logistic regression. Tree-based models: decision tree classifiers. Support vector machines, margin maximization, kernel tricks. Ensemble learning: bagging, boosting, random forests. Instance-based learning: k-NN and distance-based methods. Cluster analysis: partition and density-based methods. Hierarchical clustering and comparison of clustering approaches. Reinforcement learning fundamentals, recent advances and research directions in ML.

Mitchell, T. M., Machine Learning, McGraw-Hill.
Müller, A. C., and Guido, S., (2016), Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Reilly Media.
Alpaydin, E., Introduction to Machine Learning, 4th Edition, MIT Press.

Shalev-Shwartz, S., and Ben-David, S., Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.
Deisenroth, M. P., Faisal, A. A., and Ong, C. S., (2020), Mathematics for Machine Learning, Cambridge University Press.
Bishop, C. M., (2006), Pattern Recognition and Machine Learning, Springer.

MA480MN DEEP LEARNING AND APPLICATIONS (2-1-0) 3

Historical developments in neural networks, Introduction and Applications of deep learning. Recap of mathematical and statistical foundations for DL, Recap of Machine learning methods, Perceptrons and multilayer perceptrons, Activation functions, Universal approximation theorem, Output layers and loss functions. Gradient descent variants, Backpropagation algorithm, Weight initialization, Challenges: vanishing/exploding gradients. Regularization in DL: Weight Decay, L1 and L2 regularization, Dropout, Early stopping, Data augmentation. Optimization: Stochastic gradient descent, Momentum, RMSProp, Adam, Learning rate schedules, Second-order methods (overview). Convolution operation, Pooling and padding, CNN architectures, Applications in vision. Recurrent neural networks (RNNs), Backpropagation through time, LSTM and GRU, Applications in language and time series. Hyperparameter tuning, Model selection and evaluation, Deployment considerations, Ethical and societal aspects, Popular deep learning architectures, Generative models: AEs, VAEs, GAN, Networks. An introduction to Attention models:

Goodfellow, I., Bengio, Y., Courville, A. Deep learning (Vol. 1). Cambridge: MIT press. Aur´elien G´eron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems,"Second Edition, O'Reilly Media,2019. Francois Chollet "Deep Learning with Python," First Edition, Manning Publication 2017.
Sudharsan Ravichandran "Hands-On Deep Learning Algorithms with Python," First Edition, Packt Publishing, 2019

Minor in Computer Science and Engineering

CS202MN DATA STRUCTURES AND ALGORITHMS (3-0-0) 3

Introduction to Data Structures & Algorithms: Definition and classification of data structures, Abstract Data Types (ADT), Role of algorithms in problem solving. Algorithm Analysis & Design Techniques: Time and space complexity, Asymptotic notations (Big-O, Ω, Θ), Best, average, and worst-case analysis, Dynamic Memory Allocation: Static vs dynamic memory allocation. Linked Lists: Singly linked list, Doubly linked list, Circular linked list, Operations and applications of linked lists. Searching Algorithms: Linear search, Binary search, Performance comparison, Applications of searching algorithms. Sorting Algorithms: Bubble sort, Selection sort, Insertion sort, Merge sort, Quick sort etc, Comparison of sorting techniques. Stacks and Queues: Stack operations and applications, Queue operations and types (simple, circular, priority queue, deque), Array and linked list implementations. Recursion & Expression Evaluation: Concept of recursion, Recursive vs iterative solutions, Infix, postfix, and prefix expressions, Evaluation of arithmetic expressions using stacks. Trees: Tree terminology and properties, Binary trees, Tree traversals (inorder, preorder, postorder), Binary Search Trees (BST) and operations. Graphs: Graph terminology and types, Graph representations, Graph traversals: BFS and DFS.

Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman, Data Structures and Algorithms, Addison-Wesley, 2003.
Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures and Algorithms in C++, Universities Press, 2007.
Clifford A. Shaffer, A Practical Introduction to Data Structures and Algorithms, Prentice Hall International, 1997.
Mark Allen Weiss, Data Structures and Algorithm Analysis with C++, Addison-Wesley, 1996.
Jon Kleinberg and Éva Tardos, Algorithm Design, Addison-Wesley, 2005.

Jean-Paul Tremblay and Paul G. Sorenson, An Introduction to Data Structures with Applications, Tata McGraw-Hill, 2001.
Cormen, Leiserson, Rivest, and Stein,"Introduction to Algorithms", MIT Press, Third Edition, 2009.
Jeff Erickson, Algorithms, 1st Edition, 2019.
NPTEL: https://nptel.ac.in/courses/106102064
Coursera: https://www.coursera.org/learn/msft-data-structures-and-algorithms

CS251MN DATABASE SYSTEMS (3-0-0) 3

Database Systems, database concepts and architecture, data models, database schema and instances, entity-relationship model, relational model, relational algebra, relational calculus, SQL, advanced SQL, database design, functional dependencies, normalization, decomposition, integrity constraints, transaction management, concurrency control, database recovery, indexing and hashing, file organization, query processing and optimization, database security and authorization, database administration, and introduction to modern database systems. .

Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson;
C. J. Date, An Introduction to Database Systems, 8th Edition, Pearson;
Abraham Silberschatz, Henry F. Korth and S. Sudarshan, Database System Concepts, 7th Edition, McGraw-Hill; Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw-Hill; Thomas Connolly and Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition, Pearson;
Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widom, Database Systems: The Complete Book, 2nd Edition, Pearson;

CS252MN OPERATING SYSTEMS (3-0-0) 3

Introduction to Operating Systems - OS concepts, functions and types. Process Management - Process states, PCB and process creation. CPU Scheduling - Scheduling criteria and scheduling algorithms. Multithreading - Thread concepts and multithreading models. Synchronization - Critical section, semaphores and monitors. Deadlocks - Prevention, avoidance and recovery. Memory Management - Paging, segmentation and virtual memory. File Systems - File organization and allocation. Disk Scheduling - Disk scheduling algorithms and management.

Silberschatz, Galvin & Gagne, "Operating System Concepts", 9th Edition, John Wiley & Sons, 2013.
Milan Milenković, "Operating Systems: Concepts and Design", McGraw Hill, New York, 2000.
Andrew S. Tanenbaum, Vrije University, Amsterdam, The Netherlands, Herbert Bos, "Modern Operating Systems" 2015.
Sumitabha Das, Unix Concept and applications, Tata McGraw-Hill, 2003
NPTEL-IIT madras: https://nptel.ac.in/courses/106106144
NPTEL-IIT Delhi: https://nptel.ac.in/courses/106102132
NPTEL - IISc Bangalore: https://nptel.ac.in/courses/106108101
Coursera- BITS Pilani: https://www.coursera.org/learn/bits-operating-systems
IIT Bombay lecture: https://www.cse.iitb.ac.in/~mythili/os/

CS300MN MACHINE LEARNING (3-0-0) 3

Introduction and applications of machine learning, Different Learning Paradigms, Machine learning challenges. Evaluation metrices, importance of cross validation, Overfitting and underfitting, Bias Variance trade-off. Linear Regression, Multivariate Regression, Gradient descent, Polynomial regression, Lasso regression. Classification Problems, Logistic Regression, Multiclass classification with Logistic Regression, Linear Discriminant Analysis. Instance based learning, k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN. Probability Overview, Naive Bayes Classifier, Gaussian Naive Bayes Classifier. Neural network: MP model, Perceptron, multilayer network, backpropagation, different activation and loss functions, Gradient descent optimization algorithms, Regularization for Neural Networks. Introduction to

convolutional neural networks, convolution operation, pooling operation, popular architectures like LeNet, AlexNet, VGG, ResNet, Transfer Learning Clustering: Partitional Clustering and Hierarchical Clustering. Cluster Types, Attributes and Salient Features. k-Means, Hierarchical and Density-based Clustering Algorithms. Ensemble methods: voting, bagging, boosting.

Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
Hastie, T., R. Tibshirani, and J. H. Friedman. The Elements of Statistical Learning: Data Mining, Inference and Prediction. New York, NY: Springer, 2001. ISBN: 9780387952840.
MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003. ISBN: 9780521642989.
Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
Machine Learning by Andrew Ng, Coursera, https://www.coursera.org/learn/machine-learning
Google Machine Learning Crash Course, https://developers.google.com/machine-learning/crash-course
Machine Learning with Python – IBM, Coursera, https://www.coursera.org/learn/machine-learning-with-python
Advanced ML Algorithms & Unsupervised Learning, Coursera, https://www.coursera.org/learn/packt-advanced-ml-algorithms-unsupervised-learning-konpg
Trees, SVM and Unsupervised Learning, Coursera, https://www.classcentral.com/course/trees-svm-and-unsupervised-learning-191496
Clustering & Classification with Machine Learning in Python, Udemy, https://www.classcentral.com/course/udemy-clustering-classification-with-machine-lear-130927
NPTEL Machine Learning Courses, https://onlinecourses.nptel.ac.in/

CS301MN COMPUTER NETWORKS (3-0-0) 3

OSI and TCP/IP models, network architectures, layering principles, and protocol data units (PDUs). Physical layer, transmission media, Nyquist/Shannon capacity, line coding, and digital modulation techniques. Digital multiplexing, circuit switching, packet switching, and networking switching fabrics. Data Link Layer: Framing, error detection, and MAC sublayer. Error correction: Hamming codes, Cyclic codes, and Convolutional encoding/decoding techniques. Flow control, Ethernet, Wireless LAN, and VLANs. Network Layer: IPv4 addressing, classful vs classless (CIDR), subnetting, and IP datagram format. IPv6 transition, ICMP, DHCP, and Network Address Translation (NAT) operations and limitations. Routing algorithms: Distance Vector (RIP), Link State (OSPF), and hierarchical routing concepts. Transport Layer: UDP, TCP segment structure, connection management, flow control, and congestion control algorithms. Application layer protocols including HTTP, FTP, SMTP, DNS and client-server communication.

Kurose, James F. Computer networking: A top-down approach featuring the Internet, 6/E. Pearson Education India, 2005/2012.
Kevin R Falland W. Richard Stevens. TCP/IP illustrated, volume 1: The protocols. Addison-Wesley, 2011.
Ilya Grigorik, High Performance Browser Networking: What every web developer should know about networking and web performance. "O'Reilly Media, Inc.",2013.
Peterson, L. L., & Davie, B.S. Computer Networks: A Systems Approach. Elsevier, 2007.
Tanenbaum, A. S., & Wetherall, D. (1996). Computer networks (pp. I-XVII). Prentice hall, 1996.
Google — The Bits and Bytes of Computer Networking
https://www.coursera.org/learn/computer-networking
Covers OSI, TCP/IP, IP addressing, routing, DNS/DHCP basics. Coursera
Cisco Networking Academy — Networking Basics
https://www.netacad.com/courses/networking-basics
Introductory networking course from Cisco. netacad.com
Swayam — Computer Networks (fundamentals)

https://onlinecourses.swayam2.ac.in/cec19_cs07/preview
Covers OSI, protocols, layers, and network models. onlinecourses.swayam2.ac.in
Great Learning Academy — Basics of Computer Networking
https://www.mygreatlearning.com/academy/learn-for-free/courses/basics-of-computer-networking
Simplilearn — Free Computer Networking Course
https://www.simplilearn.com/free-computer-networking-course-skillup
Covers OSI, TCP/IP, IP addressing, subnetting and routing. Simplilearn.com
edX — Computer Networking Courses
https://www.edx.org/learn/computer-networking

CS374MN CYBER-PHYSICAL SYSTEMS (3-0-0) 3

Overview of Security and Privacy in Cyber-Physical Systems- Defining Security and Privacy, Cybersecurity and Privacy, Physical Security and Privacy, and Cyber-Physical Terrorism. Privacy Issues for Cyber Physical Systems-CPS Reference Model, Device Level, Security and Privacy Threats in CPSs, Local Network Security for CPSs, Secure Device Bootstrapping. Security and Privacy for Cloud-Interconnected CPSs- Securely Storing CPS Data in the Cloud, Protection of CPS Data, Securely Processing CPS Data in the Cloud, and Privacy for Cloud-Based CPSs. Theoretic Metrics Quantifying Privacy in Cyber-Physical Systems- Social Perspective and Motivation. Cyber-Physical Systems and National Security Concerns- Future Attacks. Legal Considerations of Cyber-Physical Systems and the Internet of Things.

Security and Privacy in Cyber-Physical Systems- Foundations, Principles, And Applications, Fink, Glenn A., Jeschke, Sabina, Song Houbing, IEEE Press, 1 st Edn., 2018.
Cyber-Physical Systems: Architecture, Security and Application, Song Guo, Deze Zeng, Springer, 1st Ed., 2019.
Secure and Trustworthy Transportation Cyber-Physical Systems, Yunchuan Sun and Houbing Song, Springer, 1st Edn., 2017.

CS413MN REINFORCEMENT LEARNING (3-0-0) 3

Introduction and Basics of RL, Defining RL Framework and Markov Decision Process Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Tabular methods and Q-networks, Deep Q-networks, Policy optimization, Vanilla Policy Gradient Reinforce algorithm and stochastic policy search, Actor-critic methods, Advanced policy gradient, Model-based RL approach, Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL, Applying RL for real-world problems.

1. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
2. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds.
3. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
4. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

CS473MN PROJECT FOR ML MINORS (0-0-6) 3

The student must select a project in application or computational models of machine learning. The project work will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.

Minor in Economics

SM205MN MICROECONOMICS (3-0-0) 3

Exploring the Subject Matter of Economics, Markets and Welfare. The Ten Principles of Economics; Working of the economy as a whole; Thinking like an Economist: The Market Forces; Markets and Competition; The Demand and Supply; Market Equilibrium; Elasticity of Demand and Supply; Consumer and Producer Surplus. Theory of Consumer Choice; The budget constraint; Optimisation-Equilibrium. The Firm and Market Structures; Theory of Production and Cost: Production Function; Isoquants and Laws of Production; Firms in Competitive Markets; Profit maximisation and the competitive firm's supply curve. The firm's supply decision;

Firm's short-run decision to shut down; Firm's long-run decision to exit or enter a market. The Input Markets. The marginal product of labour; demand for labour; The supply of labour- the trade-off between work and leisure; Equilibrium in the labour market.

Varian, Hal R. (1992), Microeconomic Analysis, 3rd Edition, International Student Edition, W. W. Norton and Company

Gregory N Mankiw, "Principles of Economics" 6e Cengage Learning India Private Limited, New Delhi

Pindyck, Rubinfeld and Mehta: (2018): Microeconomics, 9e, Pearson Education Inc

SM255MN MACROECONOMICS (3-0-0) 3

The Economic Problem: Scarcity and Choice; Introduction to Macroeconomics, Measuring National Output and National Income; Classical Theory - Unemployment, Inflation, and Long-Run Growth; Aggregate Demand and Equilibrium Output - The Keynesian Theory of Consumption, The Government and Fiscal Policy - Government in the Economy, Fiscal Policy at Work: Multiplier Effects; Aggregate Supply – Phillips curve; Government Policy Debates

Mankiw, G. and Taylor, M.P. Macroeconomics, 7th Edition, Cengage, 2017.

Case, K.E., Fair, R.C., Oster, S.M., Principles of Macroeconomics, 13th Edition, Pearson, 2017.

Dornbusch, R., Fischer, S., and Startz, R., Macroeconomics, 12th Edition, Mc Graw Hills 2018

McDonnell, C., Brue, S., and Flynn, S., Macroeconomics: Principles, Problems, and Policies, Irwin Professional Pub; Student, Student edition, 2014.

Several research articles.

SM310MN INTRODUCTION TO INDUSTRIAL ECONOMICS AND ORGANIZATION (3-0-0) 3

Introduction to economics of industry- review of relevant microeconomic concepts; Theory of the Firm; Structure-Conduct -Performance paradigm; Market structure concepts including concentration and vertical integration;Market conduct concepts including pricing behaviour; Performance aspects including growth and profitability;Transaction cost analysis; Economics of information technology; Introduction to Game Theory-Basic elements,Prisoner's Dilemma, Nash equilibrium; Overview of latest industrial and competition policies in India.

Belleflamme, P. and Peitz M., Industrial Organization: Markets and Strategies, Second Edition, CambridgeUniversity Press, 2015.

Carlton D.W. and Perloff, J. M., Modern Industrial Organization, Fourth Edition, Pearson, 2005.

Hay, D.A. and Morris, D.J., Industrial Economics and Organization: Theory and Evidence, Oxford UniversityPress, Revised Edition, 1991.

Varian, H.R., Farrell, J. and Shapiro, C., The Economics of Information Technology: An Introduction, CambridgeUniversity Press, 2004.

Osborne, M.J. and Rubinstein, A., A Course in Game Theory, Cambridge, MIT Press, 1994.

SM355MN FINANCIAL ECONOMICS (3-0-0) 3

Financial Markets- Bonds, Equities and Derived Instruments. The time dimension – Present value and duration – The term structure of interest rates– Measurement of risk. Stock market operations – Money market funds. Stock exchanges – The over-the-counter stock market – Operational efficiency and the Efficient Market Hypothesis (EMH) – The weak, semi-strong and the strong form of EMH. The Capital Asset Pricing Model (CAPM) – Estimating betas- Implications for portfolio management – Validity of CAPM – Arbitrage Pricing

theory- Fama-French model. Stock indices- Price Indices and Total Return Indices. Uses of Derivatives – Forwards- Futures - Options – The origins of Futures trading. Relation among spot and futures prices – financial futures – commodity futures – Derivative Market Participants – Futures and portfolio management. The pay offs from buying and selling options – Boundary conditions on option prices – The put-call parity– The Black-Scholes formula.

Houthakkar H.S. and Williamson P.J. (1996), The Economics of Financial Markets, Oxford University Press

Jurgen Echberger and Ian R. Harper (1997), Financial Economics, Oxford University Press

Fabozzi (2009), Bond Markets, 7th revised edition, Pearson Publications.

Select research papers.

SM410MN DEVELOPMENT ECONOMICS (3-0-0) 3

Introduction, distinction between Growth and Development Studies, Concept of Development, Evolution of Measures of Economic Development, Physical Quality of Life Index (PQLI), Various Dimensions of Human Development, Gender Development Index, Gender Inequality Index and Multi-dimensional Poverty Index. Adam Smith's Theory, Ricardian Theory, Malthusian Theory, Mill's Theory, Marxian Theory, Schumpeterian Theory, Keynesian Theory, Rostow's Stages of Growth, Harrod-Domar Model, the Solow model and its variants, endogenous growth models. East Asian Miracle, East Asian Crisis, Latin American Economic Development, Indian Economic Performance and Reforms, China's Economic Development and Reforms and Africa's Development Experience. The Concept and Measurement of Poverty, Nature and levels of Poverty in Developing countries, Economic Inequality, Criteria of Inequality Measurement, The Lorenze Curve, Functional Distribution, Economic Growth and Income Distribution: The Kuznets Hypothesis. Human Capital Formation and Economic Development: Composition of Human Investment, problems of Human Capital Formation. Entrepreneurship and Economic Development: Qualities of Entrepreneurs, Role of Entrepreneur, Obstacles in the Growth of Entrepreneurship, Measures to Encourage Entrepreneurship. Technology and Economic Development: Role of Technology in Economic Development, Process of Technological Change, Suitability of Foreign Techniques.

Meier, G, (2001), 'The Old Generation of Development Economics and the New', Meier and J. Stiglitz (eds), Frontiers of Development Economics, World Bank.

Meier, G and J. Rauch (2009), 10 edition, Leading Issue in Economic Development, Oxford University Press, USA.

Debraj Ray, (2009) Development Economics, Oxford University Press.

Minor in Electrical and Electronics Engineering

EE271MN ELECTRIC CIRCUITS (2-1-0) 3

Review of network geometry and network reduction techniques. Network theorems. Network variables, identification of the number of degrees of freedom, the concept of order of a system, establishing the equilibrium equations, network Modelling based on energy-indicating (state) variables in the standard form, natural frequencies and natural response of a network. Introduction to system functions, inclusion of forcing functions, solution methodology to obtain complete solution in the time-domain - the vector-matrix approach. Analysis of network response (in the timedomain) for mathematically describable excitations. Solution strategy for periodic excitations. The phenomenon of resonance and its mathematical analysis. Sinusoidal steady state analysis. Introduction to three-phase systems. Magnetic circuit calculations.

Textbooks: Ernst A. Guillemin, Introductory Circuit Theory, John Wiley and Sons, 1953.
Charles A. Desoer, Ernest S. Kuh, Basic Circuit Theory, McGraw-Hill, 1969
D. P. Kothari and I J Nagrath. Basic Electrical Engineering, Tata McGraw Hill, Third Edition.

Edward Hughes – Electrical technology (Ed-7) Longman, 1995.
William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, 6th Edition, TMH, 2002.
H. Cotton, Advanced Electrical technology, Wheeler, 1983.
V. Del Toro, "Electrical Engineering Fundamentals", 2nd Edition, Pearson Education.
Handbooks: Harish C. Rai & Shivanshu Rai, Handbook of Basic Electrical Engineering Formulae.
Wai-kai Chen, The Electrical Engineering Handbook, CRC Press.
SWAYAM: Basic Electrical Circuits, Prof. Gajendranath Chowdary, IIT Madras,
https://nptel.ac.in/courses/117106108
Basic Electrical Circuits, Dr. Nagendra Krishnapura, IIT Madras, https://nptel.ac.in/courses/108106172

EE371MN BASIC ELECTRIC MACHINES (2-1-0) 3

Review of power network structures, principle of energy conversion. Transformers: Principle, construction, development of equivalent circuit through coupled circuit approach, phasor diagram, regulation, efficiency, autotransformers. Induction machines: Principle, construction, classification, equivalent circuit, phasor diagram, characteristics, starting techniques, speed control, effect of single-phasing. Single-phase induction motor. DC Machines: Construction, classification, emf and torque equations, characteristics of DC motors, speed control, brushless DC motor. Stepper motor: Construction, principle of operation and control. Synchronous machines: Construction, prime-mover and excitation control systems. Steady state characteristics, voltage regulation calculations by synchronous impedance method. Synchronous motors and condensors, Permanent magnet synchronous motors, Switched reluctance motors.

Textbooks: A. E. Fitzgerald, Charles Kingsley Jr. and Stephen D Umans, Electric Machinery, McGraw Hill, Sixth Edition, 2003.
Stephen. J. Chapman, Electric Machinery Fundamentals, 5th ed. New York, NY, USA: McGraw-Hill Education, 2012.
Handbooks: 1. M.G. Say, "The Performance and Design of Alternating Current Machines", CBS Publishers, 1983.
2. D.P. Kothari and I.J. Nagrath, "Electric Machines," Tata McGraw Hill Education, Fourth Edition, 2010.
SWAYAM: Prof. G. Bhuvaneshwari, "Electrical Machines", IIT Delhi.
https://onlinecourses.nptel.ac.in/noc21_ee24/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – I", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc25_ee124/preview
Prof. Tapas Kumar Bhattacharya, "Electrical Machines – II", IIT Kharagpur.,
https://onlinecourses.nptel.ac.in/noc23_ee55/preview
Dr. A. Venkadesan, "Induction, Synchronous and Special Electrical Machines", NIT Puducherry.,
https://onlinecourses.swayam2.ac.in/ntr25_ed135/preview

EE372MN ELECTRIC POWER SYSTEM (2-1-0) 3

Electrical energy sources, power network structure and its components. per unit representation, single-line diagram representation. AC, AC-DC, and DG- based systems, forms of field energy, concepts of real and reactive powers and their conventions. Power system operation and control: State of operation of a power system, voltage and frequency control mechanisms, power generation, Introduction to tariff structure. Transmission lines: Design, Modelling and performance analysis. Cables, insulators, grounding and safety. System Modelling. Steady state analysis: power flow – NR Method. balanced and unbalanced short circuit analysis. Stability analysis: Classification, rotor angle stability of SMIB -- solution method using equal-area criteria.

Textbooks: John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994.
P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.
Handbooks: A. R. Bergen and V. Vittal, "Power Systems Analysis", Prentice-Hall, 2000.
J. D. Glover, T. J. Overbye and M. S. Sarma, "Power System Analysis & Design", Cengage Learning, 2015.

SWAYAM: Prof. Debapriya Das, "Power System Analysis", IIT Kharagpur.
https://onlinecourses.nptel.ac.in/noc19_ee62/preview

EE471MN ELECTRICAL AND ELECTRONICS MEASURING INSTRUMENTS AND TECHNIQUES (2-1-0) 3

Review of units, standards, dimensional analysis. Measurement basics: accuracy, precision, significant figures, errors (quantification and analysis), calibration. Measuring instruments: Analog and digital, Concept of true rms, DVM, multi-meter DMM, resolution, sensitivity. Oscilloscope: specifications, applications. Measurement of voltage, current, frequency, impedance, harmonics, power, power factor, and energy. Extension of meter ranges: Shunts & multipliers, CTs and PTs. Measurement of R, L, C and applications. Indicating, recording and integrating type of instruments. Measurement of non-electrical quantities (Displacement, Pressure, Temperature, Strain, Acoustic, flow and Photo measurement etc.) and instrumentation. Basics of transducers.

Textbooks: Golding and Widdis, Electrical Measurements and Measuring Instruments, Wheeler Publishing House, New Delhi 1979.
K. Sawhney, A Course in Electrical Measurement and Measuring Instruments, Dhanpat Rai and Sons, New Delhi 2007. M. B. Stout, 'Basic Electrical Measurements', Prentice Hall, 1960
Handbooks: B. S. Sonde, 'Transducers and Display Systems', Published by McGraw-Hill Inc., US, 1978.
SWAYAM: Electrical Measurement and Electronic Instruments, IIT Kharagpur,
https://nptel.ac.in/courses/108105153

EE472MN POWER ELECTRONICS IN POWER CONTROL (2-1-0) 3

Devices: Characteristics- diode, BJT, IGBT, MOSFET, IPMs, Thyristor based devices: SCRs/TRIAC/GTOs. Reactive elements: capacitors, inductor, transformer, pulse transformer. Data sheets, switching and conduction losses, heat dissipation- heat sink, loss calculation. Drive circuit, current and voltage sensors, opto-couplers. Functional classification of converters: DC-DC converters - switched mode buck converter, switched mode boost converter: control circuit, snubber, applications. Inverters: H-Bridge, single-phase, three-phase inverters. Rectifiers: single-phase and three-phase rectifiers. AC power controllers. Simulations of power electronic converters.

Textbooks: D. W. Hart, Power Electronics, New York, NY, USA: McGraw-Hill, 2010.
N. Mohan, T. Undeland, W. Robbins, Power Electronics: Converters Applications and Design, New York: Wiley, 1995.
M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, 2nd ed., Englewood Cliffs, NJ: Prentice Hall.
L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Kluwer Academic Publisher.
Handbooks: P. C. Sen, Modern Power Electronics, S. Chand & Company Ltd., New Delhi, 2nd Edition.
SWAYAM: L. Umanand. Fundamental of Power Electronics, SWAYAM–NPTEL IISc Bangalore,
https://onlinecourses.swayam2.ac.in/ntr25_ed137/preview

Minor in Electronics and Communication Engineering

EC307MN DIGITAL ELECTRONICS (3-0-0) 3

Introduction to Boolean Algebra and Switching Functions, Boolean Minimization, Finite State Machines, Design of synchronous FSMs, FSM Minimization, Bipolar Logic Families – TTL, MOS logic families (NMOS and CMOS), and their electrical behaviour. Memory Elements, Timing circuits, Elementary combinational and sequential digital circuits: adders, comparators, shift registers, counters. Logic Implementation using Programmable Devices (ROM, PLA, FPGA).

Morris. M. Mano, Michael D. Ciletti, Digital Design, Fourth Edition, Prentice-Hall India. 2008.

Charles. H. Roth, Jr., Fundamentals of Logic Design, Fifth Edition, Thomson Brooks/Cole, 2005.
J.F. Wakerly, Digital Design Principles and Practices, PH, 1999.
D.D. Givone, Digital Principles and Design, TMH, 2002

EC372MN ANALOG ELECTRONIC CIRCUITS (3-0-0) 3

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short, Analysis of simple operational amplifier circuits, Frequency response of amplifiers, Bode plots. Feedback: Feedback topologies and analysis for discrete transistor amplifiers, stabillity of feedback circuits using Barkhausen criteria. Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers, Current and voltage sources, non-linear applications of operational amplifiers: Comparators, clippers and clampers, Precision rectifiers, Waveform Generation: Sinusoidal feedback oscillators, Relaxation oscillators, square-triangle oscillators. Practical perational amplifiers: Non-idealities and their on circuit performance. Analog and Digital interface circuits: Relays, S/H circuits, Opto-couplers, A/D, D/A Converters.

Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson, 2015

EC308MN SIGNALS AND SYSTEMS (3-0-0) 3

Sinusoids – complex exponentials and phasor, Spectrum representation – spectrum of sum of sinusoids, Periodic signals, Fourier series representation, synthesis. Sampling and aliasing – sampling of sinusoidal signals, aliasing, sampling theorem, reconstruction. Discrete time FIR systems – moving average filter, general FIR filter, impulse filter, implementation of FIR filters, LTI systems, convolution, frequency response of FIR systems. Z Transform: Definition and properties, ROC, inverse Z transform, transfer function, poles and zeros, application of Z transforms to discrete-time systems. Discrete time IIR systems – Impulse response, step response, representation of LTI systems, frequency response of IIR systems. Applications of DSP – Sinusoidal synthesis, Image denoising,

Mc Chellan, R.W. Schafer & Yoder, Signal Processing First, Pearson 2003.
Sergio Franco, Design with OPAMPS and Linear Integrated circuits, Tata McGraw Hill, 2002. Ron Mancini, Op Amp for Everyone, Texas Instruments, 2002

EC373MN COMMUNICATION SYSTEMS (3-0-0) 3

Amplitude Modulation, Time & Frequency domain description, Modulation techniques, Switching modulator, Demodulation techniques, Envelope detector, Coherent detection, Costas Receiver, The Superheterodyne Receiver, Quadrature Carrier Multiplexing, Single side band and vestigial sideband modulation, Frequency Translation, Frequency Division Multiplexing. Angle Modulation, Basic definitions, Frequency Modulation, Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase–Locked Loops and their application in FM demodulation. Theme example: FM stereo broadcast. Noise in Analog Modulation, Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and Deemphasis in FM. Digital Representation of analog signals, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, Quantization Process, Quantization Noise, Pulse Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing, Application to Vocoders.

M. F. Mesiya, "Contemporary Communication Systems", McGrawHill, 2013.
Steven W. Ellingson, "Radio Systems Engineering", Cambridge University Press, 2016.
Taub and Schilling, "Principles of Communication systems", Second Edition, Tata McGrawHill, 2006 Proakis and Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson International, 2014.
Simon Haykin, "Communication Systems", Fourth Edition, Wiley, 2000.

EC309MN DATA COMMUNICATION AND NETWORKS (3-0-0) 3

Data encoding and transmission concepts, Digital data transmission, NRZ encoding, Multilevel binary encoding, Biphase encoding, Scrambling techniques, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Performance of digital and analog modulation schemes, Quadrature Amplitude Modulation (QAM), Pulse Code Modulation, Non-linear encoding, Delta modulation, Asynchronous transmission, Synchronous transmission, Ethernet link layer frame example. Switching techniques, Multiplexing and Multiple Access techniques, Packet Switched Networks. OSI and TCP/IP Models, Internet protocols and addressing, networking devices, data links and transmission, LANs and Network of LANS, Wireless Networks and Mobile IP, Routing and internetworking, transport and end to end protocols, congestion control techniques, Application Layer and network management, Network Security. Packet Queues and delays, Little's theorem, Birth and death process, Queuing disciplines, M/M/1 Queues, Burkes and Jackson theorems. Traffic models, ISDN, ATM Networks, Quality of service and resource allocation, VPNs and MPLS, Cellular Telephone and Optical networks, VOIP and Multimedia networking. Mobile Adhoc Networks and Wireless Sensor Networks.

Nader F. Mir, Computer and Communication Networks, Pearson Education, 2007 Garcia and Widjaja, Communication Networks, McGraw Hill, 2006
J.F. Hayes, Modelling and analysis of Computer Comm. Networks, Plenum, 1984.
Jean Walrand & Pravin Varaiya, High-Performance Communication Networks, Morgan Kaufmann Publishers, 2002 Taub and Schilling, "Principles of Communication systems", Second Edition, Tata McGrawHill, 2006 Proakis and Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson International, 2014. Simon Haykin, "Communication Systems", Fourth Edition, Wiley, 2000.

Minor in Information Technology

IT200MN OBJECT ORIENTED PROGRAMMING (2-0-2) 3

Fundamentals of OOP: classes and objects, abstraction, encapsulation, inheritance, polymorphism, and message passing, object creation, memory management, and basic exception handling using an object-oriented language such as Java or C++. Exercises on dynamic binding, templates/generics, file handling, and standard libraries (STL in C++ and Collections Framework in Java), enabling comparison between the two languages. Factory, Abstract Factory.

Schildt, H. (2022). Java: The complete reference (12th ed.). McGraw Hill Education.
Stroustrup, B. (2013). The C++ programming language (4th ed.). Addison-Wesley.
Booch, G., Rumbaugh, J., & Jacobson, I. (2005). The unified Modelling language user guide (2nd ed.). Addison-Wesley.
Freeman, E., Robson, E., Bates, B., & Sierra, K. (2020). Head first design patterns (2nd ed.). O'Reilly Media.
Gamma, E., Helm, R., Johnson, R., &Vlissides, J. (1994). Design patterns: Elements of reusable object-oriented software. Addison-Wesley.

IT204MN DATA STRUCTURES (2-0-2) 3

Elementary Data Types and Abstract Data Types. Computational model and complexity of algorithms (running time and space metrics), Introduction to Asymptotic notation; Worst-case, Best-case, Average-case and amortized analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT and its implementation using arrays and linked lists. Types of linked lists: Single, Double, circular linked lists and their applications. Stack ADT and Queue ADT implementations with applications. Dynamic set ADT and Dictionary ADT. Hash tables – collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, B-trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Bubble sort, Selection sort, insertion Sort, Merge sort and Quick sort. Linear-time sorting algorithms

like Radix and Counting sort. Graphs: Definitions and representations. Depth-first and breadth-first search and their applications.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.
Alfred V Aho, John E Hopcroft, Jeffrey D Ullman, "Data Structures and Algorithms", Addison Wesley, 2003.
T H Cormen, C E Leiserson, R L Rivest, and C Stein, Introduction to Algorithms, 3rd Edition, PHI Learning, 2010.
S. Horowitz. Fundamentals of Data Structures in C, Universities Press, 2nd Edition, 2008.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Knuth D.E., The Art of Computer Programming, Vol. I: Fundamental Algorithms, Addison Wesley, 3rd Ed., 1997.
Mark Allen Weiss, Algorithms Data structures and problem solving with C++, Addison Wesley,1996
Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Pearson, 2011

IT250MN DESIGN AND ANALYSIS OF ALGORITHMS (2-0-2) 3

Models of computation, Proof techniques for correctness, Proving correctness of recursive and non-recursive algorithms, algorithm analysis and asymptotic notation, time and space complexity, average and worst-case analysis, lower bounds. Recurrence Tree and Master Method. Amortised analysis. Basics of recursion divide and conquer (Integer Multiplication, Inversions, Closest Pair of Points, Merge Sort, Quicksort etc.) with proof of correctness and analysis, greedy algorithms (scheduling, Huffman coding, Minimum Spanning tree algorithms, Shortest Path Algorithms etc.) with correctness proofs, dynamic programming (Knapsack, Matrix Multiplication, Optimal Binary Search Tree, Weighted Independent Set, Interval Scheduling etc.) with correctness proofs, Backtracking and branch-and-bound. The applications of the Techniques. Introduction to Randomised Algorithms (Game Tree Evaluation, Quicksort, Order statistics, Min-Cut problem, etc). Reductions and the theory of NP Completeness: Class P, NP, NP-Complete, Proving problems are NP-Complete: 3-SAT, Vertex Cover, Subset-Sum, Partition, Introduction to Approximation algorithms.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S. Dasgupta, C. Papadimitriou, and U. Vazirani, Algorithms, McGraw-Hill Education, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3rd Edition, PHI, 2010.
Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2nd Edition, 2013.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2nd Edition, 2009
Michael R. Garey, David S. Johnson, Computers and Intractability: A Guide to the Theory of NP-completeness, W.H. Freeman& Co Ltd, 1979.

IT251MN DATABASE SYSTEMS (2-0-2) 3

Basic Concepts, Data models: ER, EER; Logical Database Design: Normalization; Physical Database Design: Storage organization, Indexing; Query Languages – Procedural, Non-procedural, SQL; Query Processing, Transaction processing: Concurrency Control and Recovery; Current trends in database systems.

Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2014
R. Elmasri and S.B Navathe, Fundamentals of Database Systems,7th Ed., Pearson, 2017
Silberschatz, Korth A.F., Sudarshan S., Database System Concepts, 6th Ed., McGraw-Hill,2010.

IT304MN WEB TECHNOLOGIES AND APPLICATIONS (2-0-2) 3

Internet and World Wide Web – Web system architecture, client-server and multi-tier architectures, Web clients and Web servers, Application servers and middleware, introduction to cloud-based web deployment models. Hypertext Transfer Protocol, HTTP/1.1, HTTP/2 and overview of HTTP/3, HTTPS, WebSockets, WebRTC, Client-side programming with XHTML, HTML5, CSS3, Responsive Web design principles, Event-driven programming with JavaScript, Server-side programming, request handling and routing, sessions and session

tracking techniques, state management in web applications; Microservices architecture, REST based microservices, Web frameworks – MVC and component based frameworks, Applications and research trends.

Robert W. Sebesta, Programming the World Wide Web, 9th Edition, Pearson Education, 2018.
Paul Deitel and Harvey Deitel, Internet and World Wide Web How to Program, 6th Edition, Pearson Education, 2019.
Sam Newman, Building Microservices, 2nd Edition, O'Reilly Media, 2021.
Leonard Richardson, Mike Amundsen and Sam Ruby, RESTful Web APIs, O'Reilly Media, 2013.

Minor in Management

SM200MN FINANCIAL MANAGEMENT (3-0-0) 3

General Financial Environment – Introduction – Capital, Secondary and Money Markets, Basics, Instruments,Financing and Rating Institutions, and legal environment. - Corporate Financial Objectives and Functions – FinancialAnalysis, Ratio analysis, Common size statement analysis, Trend analysis, Sickness prediction - Funds Flow analysis- Risk and Return Portfolio Theory - Sources of Funds , Types, Issuing and Pricing, Valuation of Stocks and bonds -Dividend Policy - Capital Structure Decision, Capital Structure Theories - Valuation Of The Firm – EvaluationTechniques, Evaluation Of Lease Contracts - Corporate Restructuring, Mergers And Acquisitions – FinancialRestructuring, - Working Capital Management

Van Horne James C., Financial Management Policy, Prentice of India, (9th Edition)

Pandey I.M., FinancialManagement, Vikas Publications House, (7th Edition) Chandra, P., Fundamentals of Financial Management, TMH

SM250MN HUMAN RESOURCE MANAGEMENT (3-0-0) 3

Overview Of HRM, Strategic HRM, HR Planning, Job Analysis, Recruitment And Selection, Human ResourceDevelopment, Performance Assessment And Management, Compensation System, Incentives And Benefits, SafetyAnd Health, Labour Relations, Multinational HRM, Role Of Culture, Legislations Pertaining To Labour Acquisition,Compensation And Maintenance, Emerging Issues In HRM.

Michel Armstrong, Human Resource Management, 5th Edition, 2006

V S P Rao, Human Resource Management, PHI, 7th Edition, 2004

Cynthia D. Fisher, Human Resource Management, Biztantra, 5th Edition, 2004.

Flippo Edwin B., Principles of Personnel Management- McGraw Hill – Kogak.

SM305MN BUSINESS ANALYTICS AND DECISION MAKING (3-0-0) 3

Analytical decision making: emerging business environment- analytical competition-embedding analytic in businessprocess- reporting / descriptive analytics, modeling or predictive analytics, data-driven strategies-analytics andbusiness performance- building analytical culture- industry trends in analytics-review techniques and tools. Businesscontexts-stages of enhanced analytics capabilities-defining metrics- categories and levels of metrics-defining KPIslinkingstrategic outcomes and KPIs- KPI directories for different industry segments-aligning technologies inanalytics domain. Blue printing a solution framework: identifying core KPIs- sourcing data- using high. Analysis &interpretation: gathering and reporting-use of dashboards and other visualizations tools-interpretations of analysissuggestingstrategic and tactical programs. Project development: industry inputs- validation of models- frameworksdataanalytics.

Davenport Tom, Harris Jeanne G., Morison Robert, Analytics at Work: Smarter Decisions, Better Results, (February 2010)

Davenport Thomas H., Harris Jeanne G., Competing on Analytics: The New Science of Winning, (March 2007)

SM350MN ENTREPRENEURSHIP (3-0-0) 3

Nature and importance of entrepreneurship, entrepreneurial decision-making process, role of entrepreneurship ineconomic development, National knowledge commission report, entrepreneurship- characteristics, motivation, rolemodels and support systems, entrepreneurial entry into international business, MSME's in India, intrepreneurship,entrepreneurial process - identifying and evaluating opportunities, developing business plan, assessment of resources,project appraisal and feasibility plan , creating and starting venture- legal requirements, marketing strategies,financial plans and human resources management, managing growth, concept of family business, conceptual modelsof family business, challenges facing entrepreneurs-individuals,family,groups, society, provisions for nursing sickunits.

Robert D. Hisrich and Michael P. Peters, Entrepreneurship, Mc Graw – Hill, 2006

Donald Roratko & Richard Hodgetts ,Entrepreneurship – A contemporary approach , PHI, 2007 David holt , New venture Creation - , Prentice hall India, 5TH ED, 2008

SM405MN MARKETING MANAGEMENT (3-0-0) 3

Introduction to Marketing - Marketing Process - Marketing Environment - Marketing Research – DemandForecasting - Competition - Marketing Strategy - Consumer Behaviour- Industrial Marketing - Customer Satisfaction- Segmentation - Targeting, Positioning Developing New Market Offerings - Product Life Cycle - Designing GlobalMarket Offerings - Product and Branding Strategy - Designing and Managing Services - Developing Pricing Strategy- Advertising Strategy - Media Planning - Marketing Channels - Retailing - Marketing Communication –Advertising.

Philip Kotler and Kevin Lane Keller Marketing Management, Pearson, 12th Edition, 2006.

Philip Kotler and Gary Armstrong, Principles of Marketing, Prentice Hall, 13th Edition, 2009.

Philip Kotler, Kevin Lane Keller , Abraham Koshy and Mithileshwar Jha , Marketing Management: A South Asian Perspective, Pearson Education; 12th Edition, 2007.

Tapan K Panda Marketing Management: Indian Context , Excel Books, 2008

Minor in Mechanical Engineering

ME501MN MANUFACTURING ENGINEERING (3-0-0) 3

Metal casting processes: Introduction to sand moulding, patterns Use f core, other casting processes: shell moulding, precision investment casting, permanent mould casting, die casting, vacuum die casting, Low pressure die casting, centrifugal casting, gating and risering, casting defects. Machining: Introduction, Mechanism of Chip Formation, Heat Generation and Cutting, Tool Temperature, Failure of Cutting Tool and Tool Wear, Cutting Tool Materials, Tool Life and Machinability, Machining processes: Shaping and Planning, Turning and Boring, Drilling. Introduction to metal forming processes: Strain rates in metal forming, Development of metallurgical structure during deformation Flow curves, Forging, Extrusion, Wire drawing, Deep drawing Metal joining processes: Gas Welding, Arc Welding, Advanced Welding processes, Brazing Soldering.

Amitabha Ghosh, Manufacturing Science, East-West Press, 2nd edition, 2010
Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, (Fourth Edition), Pearson
Education, Asia,2000.
Metal Cutting: Theory and Practices, Bhattacharya A, New Central Book Agency, 2012.

Jain P. L., "Principles of Foundry Technology", TMH, 5nd edition,2014.
Heine, R.W., Loper, C.R., and Rosenthal, P.C., "Principles of Metal Casting", TMH, 2nd edition,2001
Mechanical Metallurgy Si Metric Edition by George E. Dieter, McGraw Hill Book Company (UK),1989.

ME502MN THERMAL ENGINEERING (3-0-0) 3

Thermodynamic Laws, Compressors, reciprocating and rotary, Steam nozzles and steam turbines, Air standard cycles, Vapour power cycles, Gas turbine cycles, performance testing of IC engines, Refrigeration cycles, vapour absorption system, Psychrometric processes. Flow of real fluids, Boundary layer theory, Flow around immersed bodies, Flow through pipes, Impact of jets, Hydraulic Machines, pumps, Turbines, Hydraulic systems. Fin heat transfer, Transient heat conduction - Lumped analysis, one dimensional transient heat conduction - Heisler chart, Convection heat transfer - Forced convection - external flow and internal flow, Boiling and condensation heat transfer, Heat exchangers, Radiation heat transfer

Holman J. P., Thermodynamics, McGraw Hill International Student Edition. Newyork, 1969. Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt) LTd., NewDelhi. 6th Edition, 2007.

ME503MN MECHANICAL DESIGN (3-0-0) 3

Introduction to elasticity, plane stress and plane strain problems, Shear force and bending moment diagram, Bending equation, Beam deflection, Compound stresses and Mohr's circle, working stresses, modes of mechanical failure, theories of failure, stress concentration, fatigue loading, Soderberg criteria, members subjected to steady and alternating loads. ASME design of transmission shafts and keys. Springs: stresses in coil springs, deflection of coil springs, Design of transmission drives: Flat-and V-belt drives, Gear drives. Kinematics of Machine elements, balancing of rotating and reciprocating systems, gyroscopic effect on two-wheeler, single Degree-of free and forced vibratory systems with and without damper

RL Norton – Machine Design, An integrated approach, Pearson Education
Asia, 2000 J.E. Shigley and Mische Mech. Engineering Design, Tata

ME504MN PRODUCTION MANAGEMENT (3-0-0) 3

Introduction, Economic Analysis, Break Even Analysis, Layout and Location of Facilities, Line Balancing, Demand

Forecasting, Inventory Control, MRP and ERP, Supply Chain Management, Aggregate Planning, Scheduling, project Management, JIT, TPS and Lean operations. Product Life cycle management

Jay Heizer, Barry Render, Operations Management, Pearson, 11th Edition, 2015
R. Panneerselvam, Production and Operations Management, PHI Learning Pvt Ltd, 2006

ME505MN INDUSTRIAL AUTOMATION (3-0-0) 3

Evolution of Automation, Automation Principles and Strategies, CNC technology, Microcontrollers, Programmable Logic Controllers, Automated Process Planning, Robotics & Flexible Manufacturing Systems. Automation in Production Systems, Industrial Control Systems, Applications of Sensors and Actuators, Material Handling and Transport Systems, Storage Systems, Manufacturing Cells, Group Technology and Cellular Manufacturing, automated Assembly and Inspection

Mikel P. Grover, Automation Production Systems and Computer Integrated Manufacturing, PHI, 2004.
P. Radha Krishna & S. Subramanian, CAD/CAM/CIM, New Age International Publishers, 2009.

Minor in Metallurgical and Materials Engineering

MT200MN PHYSICAL METALLURGY (2-1-0) 3

Structure of metals, space lattice, unit cells, crystal systems metallic crystal structures packing efficiencies, Voids, Indexing of Crystallographic planes and directions and their role in material properties and performance,

Types of solid solutions, Hume Rothery rules, Intermediate phases: Intermetallic compounds, Interstitial compounds, Electron compounds, Solidification of metals, Dendritic freezing of alloys, freezing of ingots, Porosity, homogeneous and heterogeneous nucleation, critical radius, Eutectic freezing, Macro defects—Shrinkage, Blow holes, Segregation and Other defects, Binary isomorphous system, phase rule and lever rule, Equilibrium solidification, non-equilibrium solidification, Coring. Homogenization, Micro defects: Point Defects, Line defects, Surface defects, Hot and cold working, no recrystallization temperature, Effect of temperature, composition and grain size on strain hardening, Recovery, recrystallisation and grain growth, High temperature deformation of crystalline materials, Diffusion in solids, Applications of second law of diffusion, Kirkendal effect, Application of diffusion

Sidney H. Avner, Introduction to Physical Metallurgy, McGraw Hill International Editions, 2nd edition, 19743rd Edition, 1991.
Physical Metallurgy Principles, T. E. Reed-Hill and R. Abbaschian, Thompson Asia Pvt. Limited,
V. Raghavan, Physical Metallurgy, Principles and Practice, Prentice-Hall of India Private Limited, New Delhi, 2003
V. Raghavan, Materials Science and Engineering-A first course, Prentice-Hall of India Pvt. Ltd. New Delhi, 6th edition, 2017
Mechanical Metallurgy, George E Dieter, McGraw -Hill Book Company, SI Metric Edition, 1988.

MT202MN EXTRACTIVE METALLURGY (2-0-2) 3

Introduction: Classification of mineral and ores and critical minerals. Sources of minerals: land, sea and ocean. Mineral beneficiation processes. Pyrometallurgical processes: Calcination, roasting, types of roasting, Ellingham diagram, predominance area diagram, smelting process: reduction and matte smelting. Hydrometallurgical processes: Pourbaix diagram, leaching process, type of leaching, microbial and solvent extraction, ion-exchange, precipitation, drying. Electrometallurgical processes: Electro-winning and electro-refining processes, aqueous salt and fused salt electrolysis of metals. Refining of metals: pyro, hydro, and electrometallurgical refining methods. Special techniques: vacuum arc re-melting, electron beam melting, and electro-slag re-melting. Aluminium extraction: Bayer process and Hall-Heroult process. Industrial practice in India (refinery and smelter units). ALCOA and ALCAN process. Copper extraction: Sources of copper, extraction from sulphide ores, refining, newer processes for copper extraction, hydrometallurgy of copper. Lead and zinc extraction: pyrometallurgical and hydrometallurgical extraction, recovery of byproducts, Imperial Smelting Process (ISP), lead blast furnace, refining. Perform pelletization of iron ore fines and measure pellet strength. Carry out reduction roasting of pyrolusite and determine reduction fraction. Investigate the froth flotation of a sulphide ore and determine metal recovery. Conduct acid leaching of bauxite ore in hydrochloric acid and analyze the leach liquor for iron. Measure the recovery of copper from copper sulphate solution by cementation process using iron.

H. S. Ray and A. Ghosh, Principles of extractive metallurgy, Wiley Eastern Ltd., New Delhi, 1991
H. S. Ray, R. Sridhar, and K.P. Abraham, Extraction of nonferrous metals, East West Press Pvt. Ltd., New Delhi, 2007.
M. Shamsuddin, Physical Chemistry of Metallurgical Processes, Second edition, R. D. Pehlke, Unit Processes of Extractive Metallurgy, Elsevier, New York, 1973.
S. Seetharaman (Ed.), Treatise on Process Metallurgy, Vol. 1, Elsevier, 2014.
F. Habashi, Principles of Extractive Metallurgy, Vol.1, Gordon and Breach, New York, 1969.
Principles of Extractive Metallurgy — NPTEL / SWAYAM
Non-Ferrous Extractive Metallurgy — NPTEL

MT203MN CERAMICS AND REFRACTORIES (2-0-2) 3

Chemical bonding; Pauling's rules; Oxide structures; Silicate structures. Structure of glasses; Defects in ceramics, Kroger-Vink notation. Ceramic powder processing; forming of ceramics. Sintering – solid state and liquid phase sintering, grain growth. Microstructure of ceramics; Physical and thermal properties of ceramics. Mechanical properties of ceramics; brittle fracture; toughening mechanisms. Formation and properties of

glasses; Cermet; Non-oxide ceramics; Cement; Advanced ceramics. Definition of refractory; Classification: Shaped and unshaped refractories; Properties and Testing of refractories; General Production method of refractories. Selection of refractories for metallurgical applications; Special types of refractories. Density measurement: bulk and apparent density; Estimation of open porosity percentage. Compressive strength measurement of the refractory bricks; Vickers' hardness. Microstructure of ceramics by Scanning Electron Microscopy.

Michel Baersoum, Fundamentals of ceramics, McGraw Hill, 1997.
W.D.Kingery, Introduction to Ceramics, Wiley Interscience, 1976.
F. H. Norton, Refractories, Mcgraw-Hill; 4 Reprint edition,1992.
A. R. Chesti, Refractories: Manufacture, Properties, and Applications, Prentice-Hall of India Private Limited, Delhi, 1986.

MT204MN POLYMER SCIENCE AND TECHNOLOGY (2-0-2) 3

Introduction to polymers - nomenclature of polymers, polymer molecular architecture, Polymerization techniques – solution, bulk, suspension and emulsion, Polymer molecular weight determination – number average, weight average, Z-average, Industrial polymers - property Requirements and polymer utilization, thermoplastics: commodity and engineering plastics, Thermosets, elastomers, natural rubber and synthetic rubbers, Thermoplastic elastomers, blends & reinforced polymers, Polymer Reactions: polymer modification, polymer degradation, Compounding and processing of polymers, Lab component: polymer synthesis, polymer processing, protein isolation and molecular weight determination, Polymer viscoelasticity: time - temperature superposition, Mechanical properties of polymer: stress-strain behaviour, fracture, creep, hardness, and impact behaviour, Basics of polymer rheology

R. O. Ebewele, Polymer Science and Technology, 1e, CRC Press, Boca Raton, 2000.
V. R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science, 1e, New Age International, New Delhi, 2011.
C.S. Brazel, S. L. Rosen, Fundamental Principles of Polymeric Materials, 3e, John Wiley, New York, 2012.
F. W. Billmeyer Jr., Textbook of polymer science, John Wiley, New York, 1996.
J. R. Fried, Polymer Science and Technology, 3e, PHI, 2014.

MT252MN PHASE DIAGRAMS AND PHASE TRANSFORMATIONS (2-1-0) 3

Thermodynamic basics, Nucleation & Growth concepts. Solid solutions, One component systems, Isomorphous systems, Coring and it's control. Phase separation, Eutectic reactions, Kinetics & Microstructure management. Peritectic reactions, Intermediate phases, Miscibility gaps, Monotectic, Syntectic, Metatectic reactions. Kinetic aspects. Eutectoid reactions, Fe-Fe3C system. Theories of ferrite, cementite and pearlite formation and effect of cooling rate. TTT & CCT diagrams, Bainite formation. Martensite formation, Variants, Kinetics, Shape memory alloys. Al alloys, Types, Precipitation hardening, Cu alloys, Types, Order-disorder systems, Sinodal systems. Ternary systems, invariant systems, Concept of projections. Calculations in ternary systems.

Alloy Phase Equilibria, Allan Prince, 1966, Elsevier.
Ternary Phase Diagrams in Materials Science, 3rd ed., 2019, DRF West and N Saunders, CRC Press
Phase Transformations in Metals & Alloys, D A Porter and Easterling, 3rd ed., 1992, CRC Press
Physical Metallurgy Principles, R Abbaschian, L Abbaschian, R E Reed-Hill, 4th Ed., 2013
ASM Metals handbook, vol 3, Alloy Phase Diagrams, 2016, Ed: Okamoto H., et al.
Phase Transformation in Materials, Ed: Gernot Kostorz, Wiley, 2001.

Minor in Mining Engineering

MN480MN MINING TECHNOLOGY (2-1-0) 3

Introduction to mining projects. Roll of mining industry in development of nation. Mine development. Basics of underground coal mining technologies. Basics of underground metal mining technologies. Basics of surface mining technologies. Application of mechanical, civil, electrical, electronics and IT in mining projects.

Tatiya R.R., Surface and underground excavation: methods, techniques and equipment, A. A. Balkema publishers, 2005.; Walker S.C. Mine Winding and Transport. Elsevier, Amsterdam 1988; Gross, C. A., Electric Machines, 1st Edition, CRC Press, 2006. Isograph; Reliability Workbench Version 13.0 User Guide; GIAN Course on IT application and data analysis in mining and other core industries.

MN481MN ROCK EXCAVATION ENGINEERING (2-1-0) 3

Rock excavation in mining and infrastructure projects. Methodologies. Mines. CNG Pipeline projects. Hydel projects, Tunnels. U/G Caverns. Ports. Material handling equipment. Selection of equipment. Excavation in sensitive areas. Project Planning and Management. Environmental impact assessment and Management. Project economics.

Stack, B., Mining and Tunneling Machine, 1978; Martin, J. W., Martin T. J., Bennett, T. P. &Martin,K. M. Surface Mining Equipment, Martin Consultants Inc., USA,1982.

MN482MN MINE SAFETY ENGINEERING (2-1-0) 3

Accident- causes and preventive measures for various accidents in mines; Accident analysis statistics. Accident cost. Accident report, Risk assessment & preparation of safety management Plan. Safety audits. Occupational hazards in mines, Hazard analysis. Hazard control by engineering approach, Hazard control by system approach. Economics of safety and cost-effectiveness. Occupational health and safety, Occupational diseases, Problems of safety and health in contractual work, Behavior based safety, Ergonomics and its application in mining.

Ridley, J & Channing, J.; Safety at Work; Butterworth - Heinemaan, Oxford, 2001; L.C. Kaku: A Study of Mine management, Legislation & General Safety; S. Ghatak: A Study of Mine management, Legislation & General Safety; C.P. Singh: Occupational safety and health in Industries and mines; Rakesh and Prasad, Legislation in Indian Mines – A critical appraisal, Ashalata Pub., Varanasi, 1986; Singh, C.P. Occupational Safety and Health in Industries and Mines, Tata McGill, 2004.

MN483MN MINE MECHANIZATION (2-1-0) 3

Equipment for excavation, transportation, processing. Selection of equipment. Tendering and processing. Maintenance. Inventory. Automation. New developments. Productivity of machines. Economics.

Amithosh Dey, Latest Development of Heavy Earth Moving Machinery, Annapurna Publishers, Dhanbad, 1995; Reese, C., Material Handling Systems: Designing for Safety and Health, CRC Press, 2000; Martin, J. W., Martin T. J., Bennett, T. P. & Martin,K. M. Surface Mining Equipment, Martin Consultants Inc., USA, 1982.

MN484MN ENVIRONMENTAL MANAGEMENT (2-1-0) 3

Environmental issues. Pollution due to mining in terms of land degradation, air and water, noise and vibrations. Socio-economic impacts. Waste management. Reclamation and rehabilitation. Environmental Impact Assessment. Risk Analysis. Disaster management. Environmental audit. Environmental economics.

Dhar, B.B., Environmental Management of Mining Operations, Ashish Publication House, New Delhi, 1991; Chadwick et al., Environmental Impacts of Coal Mining and Utilization, Pergamon Press,1992.

Minor In NADAL (NITK Academy for Defence, Adventure and Leadership)

NA201MN INTRODUCTION TO DEFENCE, ADVENTURE AND LEADERSHIP (2-0-2) 3

Indian armed forces: Pre & post -Independence history, organisation structure, impact on nation, current challenges (geopolitics, insurgency, terrorism). Opportunities in Armed Forces: Technical & non-technical careers, training academies (NDA, IMA, OTA), Officer-Like Qualities, visits to nearby defence establishments. Safety and self-defence: Outdoor safety awareness, basic self-defence techniques. Strength, endurance and fitness training: Running, cycling, wall climbing, swimming, burpees, obstacle course, etc. Leadership and teamwork: Leadership styles (MBTI) and foundation of teamwork.

Kouzes, J. M., & Posner, B. Z. (2023). The leadership challenge: How to make extraordinary things happen in organizations (7th ed.). Jossey-Bass.
Bennis, W. G. (2009). On becoming a leader (4th ed.). Basic Books.
Rama Shankar Tripathi, "History of Ancient India", Motilal Banarsidass, India. 1967.
Bharat Verma, G. M. Hiranandani, B. K. Pandey, "Indian Armed Forces", Oxford University Press, 2014.
https://www.nios.ac.in/media/documents/Physical_Education_and_Yog_373/book-2/Lesson-17.pdf

NA202MN SELF-DEFENCE AND WILDERNESS SURVIVAL (2-0-2) 3

Safety and self-defence: Emergency situations, close combat techniques, self/buddy rescue and martial arts like Kalaripayattu. First-aid techniques: Handling bleeding, fracture, burn injury, snake-bite, etc. Navigation and orientation: Use of topographic maps, compass and position of sun/ moon/ stars. Survival techniques: Fire-making, water purification, protection from wild animals and real- time emergency drills and survival tasks. Hiking and trekking: Backpack kit, preparation, precautions, day/night trekking in local places (Kudremukh, Kumara Parvata, Kemmanagundi, Kodachadri, etc.)

Belbin, R. M., & Brown, V. (2022). Team roles at work (3rd ed.). Routledge.
Grenny, J., Patterson, K., McMillan, R., Switzler, A., & Smith, B. (2023). Crucial conversations: Tools for talking when stakes are high (3rd ed.). McGraw Hill.
https://hmidarjeeling.com/
https://www.nimindia.net/

NA301MN STRATEGIC LEADERSHIP AND TEAM MANAGEMENT (2-0-2) 3

Strategic leadership: Goal, strategy and tactics, scenario mapping, situational leadership, problem-solving in stressful situations. Ethical decision-making: Complex ethical dilemmas and relevant frameworks to navigate difficult situations. Team-building: Goal-setting, responsibility and accountability, communication, keeping team members inspired and focussed, conflict-resolution. Social responsibility: Identifying, implementing and monitoring community-based team projects to understand leadership's role in societal impact.

Dirksen, J. (2021). Design thinking for training and development: Creating learning journeys that get results. ATD Press.
Kotter, J. P., Akhtar, G., & Cohen, V. (2021). Change: How organizations achieve hard-to-imagine results in uncertain and volatile times. Wiley.

NA302MN MOUNTAINEERING AND WATER SPORTS (2-0-2) 3

Rope skills and rappelling: Types of knots, basic climbing techniques, safety protocols, descending and rappelling. Rock-climbing: Equipment (ropes, harness, belay devices, etc.), safety precautions, rock climbing and descending techniques. Kayaking: Flat water kayaking, paddle techniques, manoeuvring, right of way rules, capsize recovery, self-rescue. Stand Up Paddling: Equipment, mounting, strokes, paddling and balance control. Surfing: Wave reading, advanced paddling, angled take-offs, bottom turns and traversing waves.

Chermack, T. J. (2022). Scenario planning in organizations: How to create, use, and assess scenarios (2nd ed.). Berrett-Koehler.
Engelke, C. F., & Swegan, R. B. (2024). The practice of ethical leadership: Insights from psychology and business in building an ethical bottom line. Routledge.
https://gethnaa.org/

NA401MN LEADERSHIP IN THE ARMED FORCES (2-0-2) 3

Weaponry: Types, indigenous production, maintenance and modernization. Advanced systems: Cyber warfare, robots, drones, missiles, satellites, night warfare, maritime, underwater and space security, etc. Defence organizations: DRDO, Ordnance Factories, PSUs (BEL, HAL, etc.), private companies, defence start-ups, critical supply chain, self-reliance. Officer Selection: Interaction with veteran soldiers, military leadership and management, bootcamp exercise.

Kouzes, J. M., & Posner, B. Z. (2017). Learning leadership: The five fundamentals of becoming an exemplary leader (1st ed.). Wiley.
Heifetz, R. A., & Linsky, M. (2002). Leadership on the line: Staying alive through the dangers of leadership (1st ed.). Harvard Business Review Press.
Arjun Subramaniam, "India's Wars: A Military History, 1947-1971", HarperCollins Publishers India, 2016.
Arjun Subramaniam, "India's Wars II: A Military History, 1972-2020", HarperCollins Publishers India, 2016.

Minor in Physics

Courses for B.Tech. with Physics Minor (Refer M.Sc. Physics curriculum for details)

- **PH701 Mathematical Methods-1**
- **PH702 Classical Mechanics**
- **PH703 Quantum Mechanics-1**
- **PH752 Quantum Mechanics-2**
- **PH754 Electromagnetic Theory**

Interdisciplinary Minor

Minor in Machine Learning

(Except for AI Students)

MA212MN MATHEMATICS FOR MACHINE LEARNING (4-0-0) 4

Linear Algebra: MAtrices, Systems of Linear Equations, Echelon form and Rank, LU and Cholesky decompositions, Vector Spaces, Linear Independence, Basis and dimension, Linear Mappings, Inner Products and Orthogonality, Orthogonalisation, QR decomposition, Determinant and Trace, Eigenvalues and Eigenvectors, Eigen decomposition, Singular Value Decomposition. Probability and Distributons: Construction of a Probability Space, Introduction to Discrete and Continuous Probabilities, Sum Rule, PRoduct Rule, and BAyes' Theorem , Summary Statistics and Independence, Gaussian Distribution, Conjugacy and the Exponential Family, Change of Variables. Linear Regression: Least Squares estimators of the regression parameters, Distribution of the Estimators, Analysis of Residuals, Transforming to Lilearity, weighted Lest Squares, Introduction to multiple linear regression. Dimensionality Reduction with Principal Component Analysis: Eigenvector Computation and Low-Rank Approximations, PCA in High Dimension.

Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong,"Mathematics for Machine Learning", Cambridge University Press (2020).
Gilbert Strang, "Linear Algebra and Its Applications", Cengage (2006).
Sheldon M Ross, "INTRODUCTION TO PROBABILITY AND STATISTICS FOR ENGINEERS AND SCIENTISTS", Academic Press (2014).

MA309MN MATHEMATICAL FOUNDATIONS OF DATA SCIENCE (3-1-0) 4

High-Dimensional Space: The law of large numbers, Geometry of high dimension, Unit ball and its properties, Gaussians in high Dimension, Random projection, Separating Gaussians, Fitting a spherical Gaussians to data. Best-Fit Subspace and Singular Value Decomposition: Singular vector, Singular value decomposition (SVD), Best rank-K approximations, Left singular vectors, Power method for SVD, Applications of SVD. Algorithms for Massive Data Problems: Frequency moments of data streams, Matrix algorithms using

sampling, Sketches of documents. Clustering: Introduction, k-Means and k-center clustering, Low-error clustering – Spectral Clustering, High-density clusters, Kernel methods, Recursive clustering based on sparse cuts, Dense submatrices and communities, Community finding and Graph partitioning.

Avrim Blum, John Hopcroft, and Ravindran Kannan, "Foundations of Data Science", Cambridge University Press (2020)

IT340MN MACHINE LEARNING (3-0-2) 4

Introduction, linear classification, perception update rule, Perception convergence, generalization, Maximum margin classification, Classification errors, regularization, logistic regression, Linear regression, estimator bias and variance, Active learning, non-linear predictions, kernels, kernel regression, support vector machine (SVM) and kernels, kernel optimization. Model selection ,description length, feature selection, Combining classifier, Boosting, margin and complexity, Margin and generalization, mixture models, Mixtures and the expectation maximization(EM) algorithm, EM, regularization, Clustering, Spectral clustering, Markov models, Hidden Markov models (HMMs), Bayesian networks, Learning Bayesian networks, Probabilistic inference, collaborative filtering.

Ethem Alpaydin, -Introduction to Machine Learning, Revised and Updated Edition, MIT Press, 2021
Joson Bell, Machine Learning: Hands-On for Developers and Technical Professionals 2nd Edition, 2020
Peter Flach, -MAchine LEarning: The Art and Science of Algorithms that Make Sense of Data, Indian Edition, Cambridge University Press, 2015
Stephen MArsland - MAchine Learning - An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC, Edition:2, 2018

CS422MN DEEP LEARNING (3-1-0) 4

Machine learning basics, Basic neural network models [McCulloch-Pitts Model of Neuron, Perceptron], Adaline, linear and non linear activation functions, loss functions, gradient descent method, back propagation algorithm, Deep feed forward networks, Regularization for deep learning, Convolutional neural networks, Optimization for training deep models, RNN, Autoencoders, Popular deep learning architectures published in the last 10 years, Limitations of CNN, Semi-supervised deep learning, Applications (image classification and segmentation).

Goodfellow, I., Bengio, Y., Courville, A. Deep learning (Vol. 1). Cambridge: MIT press.
Martin T hagan etc, Neural network design (2nd edition), 2014
Taqiq Rashid, Make your own Neural Network, 2016
Tom Mitchell, Machine Learning, McGraw-Hill, 1997
Y. S. Abu-Mostafa et .al , Learning from Data, AMLbook.com

CH459MN MACHINE LEARNING APPLICATIONS IN CHEMICAL ENGINEERING (0-0-6) 4

In this course, the machine learning (ML) minor program's chemical engineering students will learn how to incorporate ML-based analysis combined with first-principles-based models of chemical equipment, chemical processes, and other systems by project-based learning. Various problems in chemical engineering (such as process monitoring, diagnosis, and control, equipment/process/material design, process optimization, and process hazards analysis, etc.) that can be analysed using various ML approaches such as regression, clustering, neural networks, random forests, Bayesian networks, directed evolution, etc. will be given as project work to students. The course (project work) will be evaluated by all the faculty members who offer the ML projects in the particular semester.

CV448MN MACHINE LEARNING APPLICATIONS IN CIVIL ENGINEERING (0-0-6) 4

The student has to select a project to apply basic principles of different machine learning algorithms namely Agent Based Modelling (ABM), Artificial Neural Network (ANN), Bayesian Networks, Fuzzy Logic (FL), Genetic Algorithm (GA), or Support Vector Machine (SVM) to various Civil Engineering applications in construction

management, environmental assessment, geological investigations, structural engineering, transportation engineering, geotechnical engineering, water resources management and wastewater treatment.

CS367MN FOUNDATIONS OF CYBER-PHYSICAL SYSTEMS (3-1-0) 4

CPS concepts and requirements, CPS architectures, Key Features of CPSs, Applications, etc. Models of physical systems, Reactive Components, Properties of Components, Composing Components, Synchronous Designs, and Safety Requirements. Asynchronous Processes, Asynchronous Design Primitives, Asynchronous Coordination Protocols. Continuous and Timed Models, Hybrid Dynamical Models, Designing Hybrid Systems. Linear Hybrid Automata, Analysis of Elementary Cyber-Physical Systems. Resource scheduling, temperature and power management, real-time communication. Operating systems and hardware architecture support for CPS,CPS software synthesis.

Cyber-Physical Systems: Foundations, Principles and Applications, Houbing Song Danda Rawat Sabina Jeschke Christian Brecher, 1 st Ed., Elsevier, 2016.
Principles of Cyber-Physical Systems, Rajeev Alur, 1 st Ed., MIT Press, 2015.
Cyber-Physical Systems- From Theory to Practice, Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic 1 st Edn., CRC Press, 2016.

CS426MN REINFORCEMENT LEARNING (3-1-0) 4

Introduction and Basics of RL, Defining RL Framework and Markov Decision Process Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation,Tabular methods and Q-networks,Deep Q-networks,Policy optimization, Vanilla Policy Gradient Reinforce algorithm and stochastic policy search, Actor-critic methods, Advanced policy gradient, Model-based RL approach, Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL, Applying RL for real-world problems.

Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds.
Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

CS473MN PROJECT FOR ML MINORS (0-0-6) 4

The student has to select a project in application or computational models of machine learning. The project work will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.

EE450MN APPLICATIONS OF MACHINE LEARNING TECHNIQUES TO PROBLEMS IN ELECTRICAL ENGINEERING (3-0-2) 4

Identification of Problems that require machine learning approach. Study of Electrical Engineering Problems and selection of problems that are amenable to be tackled through machine learning techniques; Understanding the physical phenomenon of different problems in Electrical Engineering; Developing different models – Dynamic and/or steady-state; Data necessary for training and testing and validation – Data from models and fields. Hybrid Models. Representative examples could be – Classification problems: Non Intrusive Load monitoring/Energy disaggregation, detection of nature of Faults in machines and Transmission and Distribution lines; Estimation Problems: Estimation of location of Faults on overhead lines and Underground cables, Battery State-of-Charge Estimation; Control problems: Applications of ANN and Reinforcement learning to improve control performance of some selected problems in Electrical Engineering; Prediction Problems: Dynamic Ampacity Estimation of Cables and Overhead lines, Solar PV panel output prediction; Forecasting: Load Forecasting, solar PV panel output; Online Identification and Data Recovery for PMU Data Manipulation Attack.

D. Niebur and T. S. Dillon, Neural Network Applications in Power Systems, CRL Publishing Ltd. U. K., 1996.

Rafael E. Bourguet and Panos J Antsaklis, Artificial Neural Networks in Electric Power Industry – A report, Univ. of Notre Dame, April 1994.
S. O. King, How Electrical Engineering and Computer Engineering Departments are Preparing Undergraduate Students for the New Big Data, Machine Learning, and AI Paradigm: A Three-Model Overview, IEEE Global Engineering Education Conference (EDUCON), 2019.
Richard J. Povinelli, Cristinel Ababei, Henry Medeiros, Application of Machine Learning and Data Mining in Electrical Engineering – A Special issue of Energies, 2019.
Selected Publications from journals, conferences, and lecture notes developed for the purpose of this course.

EC500MN MACHINE LEARNING FOR ELECTRONICS AND COMMUNICATION ENGINEERING (3-1-0) 4

Machine learning for 5G and 6G Wireless Networks, Medical Signal and Image Processing, Satellite Image Processing and Remote Sensing, Radar Signal Processing, Tactical and Surveillance Applications, Speech and Audio Processing, VLSI, Device modelling, electronic manufacturing, Computer vision and other applications.

Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly, 2017
Ian Goodfellow, Y. Bengio and A. Courvelle, "Deep Learning", MIT Press, 2016
Li Deng and Dong Yu, "Deep Learning: Methods and Applications", 2013
Machine Learning for Audio, Image and Video Analysis", F. Camastra, Vinciarelli, Springer, 2007
Jeremy Watt and Reza Borhani, Machine Learning Foundation, Algorithms and Applications
Fa-long Luo, MAchine learning for future Wireless Communications, 2020 edition, Wiley

IT479MN MACHINE LEARNING MINOR PROJECT (0-0-6) 4

The student has to select a project in applications or computational models of Machine Learning. The project work will be evaluated internally aa per the evaluation criteria decided by the DUGC.

ME496MN APPLICATION PROJECT IN MECHANICAL ENGINEERING (0-0-6) 4

The student has to select any project from the mechanical engineering domain and apply the knowledge of Machine learning to develop the prediction, classification and optimization model. The project work will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.

MT494MN PROJECT FOR MACHINE LEARNING MINOR (0-0-6) 4

The student has to select a project in applications or computational models of Machine Learning related to Materials processing/Materials Engineering/Nanotechnology. The project work will be evaluated as per the evaluation criteria approved by the DUGC.

MI485MN PROJECT FOR MACHINE LEARNING MINOR (0-0-6) 4

The student has to select a project in mining applications of Machine Learning. The project work will evaluated internally and externally as per the evaluation criteria decided by the DUGC.

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