MANIPAL UNIVERSITY
JAIPUR

ACADEMIC HANDBOOK 2019

Faculty of Engineering

The Manipal Legacy

The Manipal Education Group is the dream of Dr. Tonse Madhav Ananth Pai. His vision is converted to India largest education township with more than 24 institutions so of learning. The Manipal Education Group is an established leader in the field of education, research, and healthcare. In over six decades, it has transformed the lives of more than 3,00,000 students from over 59 countries. The group includes five Universities - Manipal Academy of Higher Education (MAHE, Karnataka), Sikkim Manipal University (Sikkim), American University of Antigua (Caribbean Islands), Manipal International University (Malaysia) and Manipal University Jaipur (Jaipur).

The University has off-campuses in Mangalore and Bangalore, and off-shore campuses in Dubai (UAE) and Melaka (Malaysia). The Mangalore campus offers medical, dental, and nursing programs. The Bangalore Campus offers programs in Regenerative Medicine. The Dubai campus offers programs in engineering, management, and architecture, and the Melaka campus offers programs in medicine and dentistry. Manipal Group is proud to build in Jaipur, a multi-disciplinary university, offering courses across disciplines. Every institute has world- class facilities and pedagogy, which are regularly reviewed and upgraded to reflect the latest trends and developments in higher education.

Manipal University Jaipur

Manipal University Jaipur (MUJ) was launched in 2011 on an invitation from the Government of Rajasthan, as a self-financed State University. MUJ has redefined academic excellence in the region, with the Manipal way of learning; one that inspires students of all disciplines to learn and innovate through hands-on practical experience.

Jaipur, is one of the fastest growing cities in India, has increased demand for quality higher education in the region. Following an allotment of 122 Acres of land at Dehmi Kalan village near Jaipur, the permanent campus of the University has come up at a fast pace and is by far one of the best campus in the region.

The multi-disciplinary University offers career-oriented courses at all levels, i.e., UG, PG and doctoral and across various streams, including Engineering, Architecture, Planning, Fashion Design, Fine Arts, Hospitality, Humanities, Journalism and Mass Communication, Basic Sciences, Law, Commerce, Computer Applications, Management, etc. Some PG programmes are also available in the research mode.

MUJ boasts of best-in-class infrastructure, including state-of-the-art research facilities and a modern, digital library. In line with Manipal University's legacy of providing quality education to its students, the campus uses the latest in technology to impart knowledge.

VISION

"Global Leadership in Higher Education and Human Development"

Leadership

Dr. G.K.Prabhu
President

Dr. N.N.Sharma
Pro-President

Dr. H.Ravishankar Kamath
Registrar

Dr. Jagannath K
Dean (Engineering)

Dr. Ajay Kumar
Director (Academics)

Dr. Sumit Srivastava
Controller of Examination

Contents

Faculty of Engineering

Faculty of Engineering (FoE) at MUJ is home for the best-in-class infrastructure to nurture Engineering education. FoE aims to foster creativity and innovation for an intellectually satisfying learning environment as well as to establish MUJ as a globally preferred destination for students, faculty, researchers, and other stakeholders. It boasts of state-of-the-art research facilities and laboratories. Under FoE, University offers Bachelor of Technology (B.Tech.) and Master of Technology (M Tech) programmes in various streams.

B.Tech. and M.Tech. programs are offered in streams like Automobile, Chemical, Civil, Computer & Communication, Computer Science, Electrical & Electronics, Electronics & Communication, Information Technology, Mechanical, and Mechatronics Engineering. The FoE consists of four schools. School of Automobile, Mechanical & Mechatronics includes Department of Automobile, Mechanical and Mechatronics. School of Electrical, Electronics & Communication Engineering has Department of Electronics & Communication Engineering and Electrical & Electronics Engineering. Department of Civil Engineering and Chemical Engineering are under the School of Civil and Chemical Engineering. School of Computing and IT includes Department of Computer & Communication Engineering, Computer Science & Engineering, and Information Technology.

"MUJ provides students with an environment conducive to learning and imbibing knowledge to make them industry ready."

Prof Jagannath K.
Dean(FoE)

ACADEMIC REGULATIONS FOR FACULTY OF ENGINEERING-2019 Onwards

1. ACADEMIC PROGRAMMES

1.1 Under FoE, the University offers Bachelor of Technology (B.Tech.) and Master of Technology (M.Tech.) programmes.

1.1.1 Duration of the B.Tech. programme is 8 semesters.

1.1.2 Duration of M.Tech. programme is 4 semesters.

1.1.3 The maximum duration for a student for complying with the Degree requirement is the actual duration of the academic programme plus 2 years from the date of joining.

2. ELIGIBILITY FOR ADMISSION

2.1 Undergraduate Programme (B.Tech.):

2.1.1 The candidate must have passed 10+2 or A-Level or IB or American 12th grade or equivalent examination with Physics, Mathematics and English as Compulsory subjects, along with any one of Chemistry or Computer Science or Biotechnology or Biology or Statistics or Engineering Drawing as optional subject for admission to B Tech, with minimum of 50% marks in Physics, Mathematics and the optional subject, put together.

2.1.2 Candidates can apply for Lateral Entry to second year B.Tech. Programme, who have passed 3-year diploma in the relevant field of Engineering/BSc (PCM) with a minimum of 50% marks in aggregate. Admissions are done on the basis of marks obtained in the qualifying examination and there is no entrance test.

2.1.3 Candidates can apply for Lateral Entry to second year B.Tech. Programme, who have passed the first year of engineering elsewhere, in recognized Indian/ Foreign University/ Institutions**.**

2.1.3.1 The credits transferred will reduce the number of courses to be registered by the student at MUJ

2.1.3.2 Maximum number of credits that can be transferred by a student shall be limited to the total number of credits for the first year, as specified by programme scheme at MUJ. However, the decision of the Dean of the Faculty concerned in this regard shall be final.

2.1.4 Eligible NRI/International students are admitted based on their qualifying examination performance.

2.2 Post Graduate Programmes (M.Tech.):

3.2.1 BE/ B.Tech./ AMIE or equivalent in relevant branch with a minimum of 50% aggregate marks in the qualifying examination

3.2.2 Eligible NRI/ International students are admitted based on their qualifying examination performance.

3.. ADMISSION PROCEDURE

3.1 Undergraduate Programme (B.Tech.): Eligible students are admitted on the basis of the rank obtained in the All India MET (Manipal Entrance Test). Seats are reserved for NRI / Foreign students.

3.2 Post Graduate Programmes (M.Tech.): Admissions are done on the basis of Personal Interview (PI) & marks obtained in the qualifying examination. There is no entrance test.

4. ACADEMIC PROCESS

4.1 Registration: Students have to register for the courses with the parent department at the commencement of each semester on the day notified in the academic calendar.

4.2 Pre-registration: Students need to pre-register for elective courses (both program & open electives) with their department for the next semester as notified in the academic calendar.

4.3 Withdrawal of course registration:

A student who has registered for a course, but desires to withdraw the registration, will be permitted to do so at any time after the registration, but at least seven days before the commencement of the first sessional examination notified in the Academic Calendar.

4.4 Academic Term:

4.4.1 Each semester has a specified course structure.
4.4.2 The first year B.Tech. course structure is common to all branches of Engineering.
4.4.3 The medium of instruction for all courses offered is English.
4.4.4 Eighth semester of B.Tech. programme as well as third & fourth semesters of M.Tech. programme is fully dedicated to project work.

4.5 Course Numbering:

4.5.1 The courses offered by each Department are coded with 2 letters indicating the department offering the course followed by 4 digits.

4.5.2 First digit indicates the level (1-5 for UG; 6-7 for PG; 8-9 for Doctoral studies), second digit indicates semester offered ('1': offered in ODD; '2': offered in EVEN; '0': offered in BOTH) and the last two digits indicate the course code.

4.5.3 The following codes are used for different departments:

S.No.	Department	Code
1	Architecture	AR
2	Arts	AT
3	Automobile Engineering	AU
4	Biosciences	BT
5	Business Administration	BB
6	Chemical Engineering	CE
7	Chemistry	CY
8	Civil Engineering	CV

9	Commerce	CM
10	Computer & Communication Engineering	CC
11	Computer Applications	CA
12	Computer Science & Engineering	CS
13	Economics	EO
14	Electrical & Electronics Engineering	EE
15	Electronics & Communication Engineering	EC
16	Fashion Design	FD
17	Fine Arts	AA
18	Hotel Management	HA
19	Information Technology	IT
20	Interior Design	ID
21	Journalism & Mass Communication	JC
22	Languages	LN
23	Law	LA
24	Mathematics	MA
25	MBA	MB
26	Mechanical Engineering	ME
27	Mechatronics Engineering	MC
28	Physics	PY
29	Planning	PL
30	Psychology	PS

4.6 Credit Based System:

4.6.1 Each course, theory as well as practical, is expressed in terms of a certain number of credits. The credits are determined by the number of contact hours per week.

For theory courses: 1 Credit = 1 Hour Lecture / Tutorial per week

For practical courses: 1 Credit = 2 or 3 contact hours per week

4.6.2 Course work in each semester is expressed in terms of a specified number of credits. A student successfully completes a particular semester when he/she earns all the credits of that semester. A student earns full credits for a subject registered if he/she secures letter grade E or higher.

4.6.3 Promotion of a student to higher semesters is based on securing a prescribed minimum number of credits as mentioned in Section 4.14.

4.7 Assessment:

4.7.1 Student performance is continuously assessed in all courses, based on class/tutorial participation, assignment work, lab work, class tests, in semester tests, quizzes and end semester examinations, which contribute to the final grade awarded in the course. The academic performance of a student is assessed by the course instructor(s) concerned.

4.7.2 The student performance in each theory course is evaluated out of 100 marks, of which 60 marks are for in-semester assessments and 40 marks are for end-semester assessment. In-

semester assessment consists of two sessional examinations of 20 marks each and CWS of 20 marks.

4.7.3 The in-semester assessment in theory courses is based on periodic tests, assignments, quizzes, case presentations, seminars, etc. which shall be defined by the course instructor.

4.7.4 The student performance in laboratory courses is also evaluated out of a maximum of 100 marks and is based on the in-semester assessment of 60 marks and end-semester examination conducted for 40 marks. Absolute grading is to be applied to lab courses.

4.7.5 Course instructors are to give the complete course plan approved by the HoD to the students, at the beginning of the semester. Course plan includes lesson plan & evaluation plan of the course offered.

4.7.6 Course instructors are to give regular feedback on the performance of students.

4.7.7 The performance of a student in a course is reflected in the Letter Grade awarded.

4.8 Attendance Requirements:

4.8.1 Students are expected to attend every lecture, tutorial and practical class scheduled for them. Attendance will be recorded for every class in every course they attend.

4.8.2 A student with less than 75% attendance in individual courses shall not be permitted to write the end semester examination in that course and will be given DT Letter Grade in the course.

4.8.3 The aggregate percentage of attendance of the student during the semester will be entered in his/her grade sheet for that semester.

4.9 Grading System:

4.9.1 10 point grading system shown is used for awarding letter grade in each course.

Letter Grade	A+	A	B	C	D	E	AP	F/I/DT
Grade Points	10	9	8	7	6	5	0	0

AP: Audit Pass F: Failure I: Incomplete DT: Attendance shortage

4.9.2 The overall performance of a student in each semester is indicated by the Grade Point Average (GPA) which is the weighted average of the grade points obtained in that semester expressed as

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where,

n=number of courses graded per semester

C = Course credits

G = Grade points

4.9.3 The overall performance of the student for the entire programme is indicated by the Cumulative Grade Point Average (CGPA) which is the weighted average of the grade points obtained across all semesters till date

$$CGPA = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i}$$

where, N=Total number of courses graded till date

4.9.4 A student who earns a minimum of 5 grade points (E grade) in a course is declared to have successfully completed the course and earned the credits assigned to it.

4.9.5 A total of 35% marks for UG programmes, 35% marks for PG and post PG programmes is essential for a student to be awarded a passing grade in any theory course.

4.9.6 A student who is eligible for, but fails to appear in, the end-semester examination will be awarded 'F' Grade. However, if he/ she fails to appear in the end semester examination due to valid reasons, (including medical, non-payment of dues or other family reasons) he/she will be awarded an 'I' (incomplete) grade. Relaxation to the award of 'I' grade is permissible, only if prior approval has been obtained before the start of the examinations.

4.9.7 If a student is not eligible to appear in the end-semester examination owing to his/her not fulfilling the minimum attendance requirements in any course, he/she will be awarded a 'DT' grade (detained) and has to re-register for the course(s) at the next available opportunity.

4.9.8 A student should have appeared for the end-semester examination of the prescribed course of study (mere appearance in the continuous assessment tests is not sufficient) to be eligible for the award of a passing grade in the course. A separate minimum of 35% of marks in the end semester examination is essential for awarding a passing grade in a theory course.

4.10 Evaluation of Project Work Dissertation/ Thesis

4.10.1 Eighth Semester B.Tech:

4.10.1.1 Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry/ research laboratory or any other institution where facilities exist, with approval of the parent Department.

4.10.1.2 The grade awarded to the student will be on the basis of the total marks obtained by him/ her out of 400 marks.

4.10.1.3 There will be a mid-semester evaluation of the work done on the project after 8-10 weeks.

4.10.1.4 In case of external projects, the qualitative feedback of the external guide shall be taken.

4.10.1.5 The final evaluation and viva-voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

4.10.2 Second year M.Tech:

4.10.2.1 A student of M.Tech. shall carry out a Project Work for a minimum of 36 weeks during the second year of the programme, in the institution/ industry/ research laboratory or any other institution where facilities exist with approval of the parent Department.

4.10.2.2 The grade awarded to the student will be on the basis of the total marks obtained by him/her out of 400 marks.

4.10.2.3 There will be a mid-term evaluation of the work after about 18 weeks by the department concerned.

4.10.2.3 The final evaluation will be conducted after the completion of the project work and submission of the dissertation by a panel of examiners consisting of an internal guide.

4.10.2.4 In case of external projects, the qualitative feedback of the external guide shall be considered during mid-semester evaluation.

4.11 Class Committee:

4.11.1 A class committee headed by the Dy. Director/ Coordinator (First year) is formed for the first year B.Tech. programme. The section coordinators, course coordinators, and student representatives of all sections will be members of this committee.

4.11.2 For III to VIII Semester of B.Tech. programme and for every semester of M.Tech. programme, separate class committees are constituted by the Heads of the respective departments. The committee is formed with a senior faculty of the Department as Chairman & Course Coordinators/Course Instructors of all courses & student representatives as members.

4.11.3 Course Coordinator: If there is more than one section, one of the senior faculty members is nominated by the HOD as Course Coordinator.

4.11.4 Functions of the Class Committee:

4.11.4.1 The class committee will meet thrice in a semester.

4.11.4.2 The first meeting will be held within two weeks from the commencement of the semester in which the course plan, evaluation plan, etc. are discussed.

4.11.4.3 The second meeting will be held two weeks after the first sessional to collect feedback and improve the effectiveness of the teaching-learning process. Performance of the students in the tests may also be analyzed.

4.11.4.4 The Chairman of the class committee should send the minutes of the class committee meeting to the Director (Academics) through the Head of the Department after each class committee meeting.

4.11.4.5 The third meeting is to be held to analyze the performance of the students in all courses of study and grade finalization. However, the student representatives are exempted from this meeting.

4.11.4.6 The CoE will declare the results after processing.

4.12 Section Committee:

4.12.1 Each section of every semester will have a Section Committee, consisting of the Section Coordinator, faculty members handling both theory and practical classes for that section and student representatives as members.

4.12.2 The Section Coordinator will be a senior faculty member who teaches at least one subject for that section. Section Coordinators will be nominated by the Dy. Director/Coordinator for the first year and by HoDs for the higher year of study, who will administer the functioning of all the Section Committees.

4.12.3 The section committee will meet periodically to review the overall effectiveness in the conduct of first year classes.

4.13 Faculty Advisors:

4.13.1 To help the students in planning their courses of study and for general advice regarding academic programmes the Head of the Department will assign one to two senior faculty members in the III semester who will be Faculty Advisors for the batch.

4.13.2 Faculty Advisor for a particular batch will continue untill the regular students complete the programme.

4.14 Promotion to Higher Semesters:

4.14.1 B.Tech. Programme: Promotion of a student from an even semester to the next higher (odd) semester is subject to securing the minimum academic performance specified.

Promotion to Higher odd semester	Minimum credits required
III	26 at the end of II semester
V	68 at the end of IV semester (including OE courses)
VII	115 at the end of VI semester (including OE courses)
IX	168 at the end of VIII semester

4.14.2 M.Tech. Courses: A student can start the project work at the beginning of the third semester only if she/he has acquired 40 credits at the end of the second semester, and he/she has to earn all the credits of the first and second semesters, before he /she is permitted to submit the project thesis.

4.15 Academic Probation and Termination of the Registration to the Programme:

4.15.1 A student who is not eligible for promotion from an even semester to the next higher odd semester for reasons of not having earned the prescribed minimum number of credits will be required to discontinue the academic programme temporarily. In such case, he/she will be put on academic probation for the next academic year, and a warning letter shall be issued.

4.15.2 If a student is repeating a semester/s due to poor academic performance, he/she will also be put on academic probation.

4.15.3 The student put on academic probation shall be periodically monitored and mentored by the faculty advisor. He/she can re-join the academic programme after fulfilling the academic requirements as in 4.14 at the end of the academic probation.

4.15.4 At the end of the academic probation year, if a student fails to acquire the minimum credits to get promoted to next higher odd semester, his/her registration for the academic programme shall be terminated.

4.16 Re-joining a Programme:

A student who discontinues the academic programme for any reason and re-joins the programme at a later date shall be governed by the rules, regulations, courses of study and syllabi in force at the time of his/her re-joining the programme.

4.17 End-Semester Examination:

4.17.1 The end semester examination will be conducted only in the courses offered in the current semester.

4.17.2 Only students with attendance ≥ 75 % will be permitted to appear for the end semester examination.

4.17.3 A separate minimum of 35% of marks in the end semester examination is essential for awarding a passing grade in a theory course.

4.17.4 A course successfully completed cannot be repeated for grade improvement. However, in special cases, students may be allowed to reject and repeat the entire semester with the consent of HoD/ Deputy Director (Academics).

4.18 Make-up examinations:

4.18.1 Make-up Examinations are conducted along with the Regular ETE of a semester only for the courses running in that semester.

4.18.2 Students who get F or I grade in their ETE, are allowed to take these Make-up Exams.

4.18.3 In addition to the above, Make-up Examinations for theory courses of both Odd/Even semesters are also conducted in the month of July every year.

4.18.4 Grades Applicable in Make-up Examination

a. The grade boundaries for Make-up Examination courses conducted along with Regular ETE will be the same as those for Regular ETE courses.

b. The grade boundaries for Make-up Examination courses conducted in July will be the same as those in the immediately preceding ETE for that course.

c. All students who appear in these Examinations (except those having I grade in the ETE), will be awarded one grade lower than what they have secured. However, a student who secures an E grade will retain the same grade.

4.19 Re-registration of courses:

4.19.1 Students with F/I/DT Grade are allowed to re-register for subjects of the lower semester along with their regular term subjects by paying the prescribed fees.

4.19.2 Students may not be permitted to re-register in courses if there are clashes in the time table.

4.19.3 The prevailing re-registration course-wise fee will have to be paid by the student.

4.19.4 Students need to attend regular classes in all such cases and have to submit assignments and appear for sessional tests along with the regular students.

4.19.4 Students are allowed to register for a maximum of 32 credits in a given semester.

4.19.5 Students are eligible to get actual graded in re-registered courses.

4.20 Withholding of Results:

Results will be withheld when a student has not paid his/her dues, or there is a case of disciplinary action pending against him/her.

4.21 Eligibility for the Award of Degree:

4.21.1 A student will be eligible for the award of the degree if:

4.21.1.1 He/she earns the required number of credits specified for all semesters.

4.21.1.2 He/she has paid all dues to the Institute.

4.21.1.3 No case of disciplinary action is pending against him/her.

4.21.2 Total number of credits required for obtaining:

4.21.2.1 B.Tech. – 169*

* Credit used for CGPA computation: 157.

Open electives, industrial training, and experiential learning, are excluded from GPA/CGPA computation.

4.21.2.2 M.Tech. - 75

4.21.3 Minimum CGPA for Graduation is 5.0 and the Maximum that can be earned is 10.

4.21.4 However, in the credits system, class/rank is not awarded.

4.22 Audit Courses:

4.22.1 Students have the option of Auditing additional courses with the consent of the course instructor.

4.22.2 On successful completion, the student will be given 'AP' letter grade.

4.22.3 The grade obtained in an audit course will not be used for the computation of CGPA.

4.23 Minor Specialization:

4.23.1 Students have the choice of getting a minor specialization along with their degrees by earning 12 credits in the prescribed set of subjects offered as electives.

4.23.2 Minor specialization shall be mentioned in the VIII semester marks card / Transcript along with CGPA.

5. Change of Branch:

5.1 Change of branch is allowed on request against vacancies before the commencement of the third semester based on academic performance of first year B. Tech.

5.2 Applications for change of branch shall be submitted to the Deputy Director (Academics), at the end of the second semester.

5.3 Consent of Parents is a must. Student should submit a written request from parents along with the application for branch change.

5.4 Merit list will be prepared based on the student's CGPA after the declaration of second semester results.

5.5 Students applying for branch change should qualify all the courses of B. Tech. first year programme in the first attempt.

5.6 Students who have secured seats under any scholarship scheme and have opted for branch change will not be eligible for the scholarship from the second year.

5.7 Mutual change of branch is not permitted.

6. Transfer of Credits:

6.1 The courses credited elsewhere, in Indian/Foreign University/ Institutions/Colleges by students during their study period at Manipal University Jaipur may be counted towards the credit requirements for the award of the degree.

6.2 Students can earn external credits only from Indian/Foreign Universities/Institutions with which MUJ has anMoU for the above purpose.

6.3 The credit transferred will reduce the number of courses to be registered by the student at Manipal University Jaipur. The guidelines of such transfer of credits are as follows:

6.3.1 B. Tech. student with consistent academic performance and CGPA ≥ 7 can credit the courses approved by the concerned Board of Studies (BoS) and ratified by Faculty Board (FB) in Engineering of Manipal University Jaipur, in other institutions during 3rd/ 4th year and during semester breaks.

6.3.2 Credit transferred will not be used for GPA/CGPA computation. However, credit transferred will be considered for the overall credit requirements of the program.

6.3.3 Credit transfer can be considered only for the courses at the same level or above.

6.3.4 Student must provide all details for the course which he is requesting for credit transfer along with the acceptance letter for the scrutiny of the concerned BoS, before proceeding for the course.

6.3.5 Maximum number of credits that can be transferred by a student shall be limited to the number of credits earned in the corresponding semester in MUJ. However, total credit

earned at the completion of degree should not be less than the required credit for the award of the degree. In case a student has earned more credits from other universities/ educational Institutions/ Research Institutions, the student may indicate his/her preference for credit transfer. However, the decision of the Dean of the Faculty concerned in this regard shall be considered as final.

6.3.6 Student has to pass all such courses for which credits transfer is to be made.

6.3.7 Credit transfer availed by a student shall be properly recorded on the academic record(s) of the student.

7. B. Tech. Honours:

7.1 Any student with CGPA ≥ 8.5 at the end of IV semester can opt for B. Tech (Honours).

7.2 Student need to earn an additional 12 credits of specified subjects at PG level or above (One each in V – VII Semesters).

7.3 Student should take up a project work related to his/her domain with at least ONE Scopus indexed Journal/Conference publication from work, as First author (8 credits) in 8^{th} semester.

7.4 Total Credits earned will be 169+20 = 189.

7.5 Student should maintain a minimum CGPA of 8.5 at the end of the program.

8. Termination from the Programme:

A student shall be required to leave the institute without the award of the degree, under the following circumstances.

8.1 If a student fails to acquire the minimum number of credits required to get promoted to the next higher semester at the end of academic probation year.

8.2 If a student fails to acquire the requirements for the completion of the degree within the maximum permissible period.

8.3 If a student is absent for more than 6 weeks at a stretch in a semester without sanctioned leave.

8.4 Based on disciplinary action, on the recommendation of an appropriate committee and approved by the President of the University.

First Year B.Tech Curriculum 2019(Common to all branches)

First Year Course Structure (Physics Group):

YEAR	FIRST SEMESTER						SECOND SEMESTER					
	Course Code	Course Name	L	T	P	C	Course Code	Course Name	L	T	P	C
I	MA1101	Engineering Mathematics-I	3	1	0	4	MA1201	Engineering Mathematics-II	3	1	0	4
	PY1001	Engineering Physics	3	1	0	4	CY1001	Engineering Chemistry	2	1	0	3
	CV1001	Basic Civil Engineering	2	1	0	3	EE1001	Basic Electrical Technology	2	1	0	3
	CY1002	Environmental Studies	3	0	0	3	CS1001	Problem Solving Using Computers	2	1	0	3
	EC1001	Basic Electronics	2	1	0	3	ME1001	Basic Mechanical Engineering	2	1	0	3
	ME1002	Engineering Graphics	0	0	6	3	LN1001	Communication Skills in English	2	0	0	2
	PY1030	Engineering Physics Lab	0	0	2	1	CS1030	Problem Solving Using Computers Lab	0	0	2	1
	ME1030	Workshop Practice	0	0	2	1	CY1030	Engineering Chemistry Lab	0	0	2	1
							DA1001	Experiential Learning	0	0	4	2
			13	04	10	22			13	05	08	22
	Total Contact Hours (L + T + P)		27				Total Contact Hours (L + T + P)		26			

First Year Course Structure (Chemistry Group):

YEAR	FIRST SEMESTER						SECOND SEMESTER					
	Course Code	Course Name	L	T	P	C	Course Code	Course Name	L	T	P	C
I	MA1201	Engineering Mathematics - II	3	1	0	4	MA1101	Engineering Mathematics – I	3	1	0	4
	CY1001	Engineering Chemistry	2	1	0	3	PY1001	Engineering Physics	3	1	0	4
	EE1001	Basic Electrical Technology	2	1	0	3	CV1001	Basic Civil Engineering	2	1	0	3
	CS1001	Problem Solving Using Computers	2	1	0	3	CY1002	Environmental Studies	3	0	0	3
	ME1001	Basic Mechanical Engineering	2	1	0	3	EC1001	Basic Electronics	2	1	0	3
	LN1001	Communication Skills in English	2	0	0	2	ME1002	Engineering Graphics	0	0	6	3
	CS1030	Problem Solving Using Computers Lab	0	0	2	1	PY1030	Engineering Physics Lab	0	0	2	1
	CY1030	Engineering Chemistry Lab	0	0	2	1	ME1030	Workshop Practice	0	0	2	1
	DA1001	Experiential Learning	0	0	4	2						
			13	05	08	22			13	04	10	22
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P)		27			

FIRST SEMESTER

MA1101: ENGINEERING MATHEMATICS – I [3 1 0 4]

Matrices-inverse and rank, solution of linear system of equations, Eigen value problems. Vector spaces, basis, linear transformations, inner product spaces and Orthogonalization. First and higher order differential equations and their solutions; finite difference and interpolation for equal and unequal intervals, Numerical differentiation and integration. Solution of algebraic and transcendental equations, solutions of ordinary differential equations.

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2. Kreyszig E., *Advanced Engineering Mathematics*, (10e), Wiley Eastern, 2011
3. Lay David C., *Linear Algebra and applications*, (3e), Pearson Education, 2009
4. Sastry S. S., *Introductory methods of Numerical analysis*, (4e), PHI, 2007
5. Iyengar S.R.K. and Jain, Rajendra K. , *Advance Engineering Mathematics (3e)*, Narosa book distributors Pvt Ltd-New Delhi, 2007
6. Ramana B. V., *Higher Engineering Mathematics* (6^{th} reprint), Tata Mcgraw-Hill, New Delhi, 2008

PY1001: Engineering Physics [3 1 0 4]

Optics: Two source interference, double slit interference, coherence, intensity in double slit interference, thin film interference, air-wedge, Newton`s rings, Michelson`s interferometer, diffraction and wave theory of light, single-slit diffraction, intensity in single-slit diffraction (using phasor method), diffraction at a circular aperture, double-slit interference and diffraction, combined-intensity in double-slit diffraction (qualitative approach), diffraction of light through multiples slits, diffraction gratings, dispersion and resolving power of gratings, polarization of electromagnetic waves, polarizing sheets, polarization by reflection, double refraction; Quantum Physics: Black body radiation and Planck`s hypothesis, Stefan`s Law, Wein`s displacement law, Photoelectric effect, Compton effect, photons and electromagnetic waves, wave properties of particles, de Broglie hypothesis, Davisson-Germer experiment, quantum particle (wave packet, phase velocity, group velocity), the uncertainty principle; Quantum Mechanics: An interpretation of quantum mechanics, wave function and its significance, Schrödinger equation, particle in a box, particle in a well of finite height (qualitative), Tunneling through a potential barrier and its applications, the simple harmonic oscillator (qualitative); Atomic Physics & Molecular Physics: Atomic spectra of gases, energy states and spectra of molecules (rotational and vibrational energy levels), X-rays spectrum, Moseley's law, spontaneous and stimulated transitions, He-Ne and Ruby laser, application of lasers; Solid State Physics: band theory of solids, electrical conduction in metals, insulators and semiconductors, Superconductivity, type-I and type-II superconductors, Meisner effect, BCS theory (Introductory) and applications of superconductivity.

References:

1. Halliday D., Resnick R., Krane K. S., *Physics* (5e), Wiley, 2016.
2. Beiser A., Mahajan S., Rai Chaudhary S., *Concepts of Modern Physics*, (7e), McGraw Hill Education, 2017.
3. Serway R. A., Jewett J. W., *Physics for Scientists and Engineers with Modern Physics*, Thomson, 2013.

CV1001: BASIC CIVIL ENGINEERING [2 1 0 3]

Introduction: Scope of Civil Engineering, Role of Civil Engineer in Society, Impact of infrastructural development on economy of country. Buildings: Properties, uses of Stones, bricks, cement, timber, steel, plastics and paints. Properties of concrete. Selection of site for Buildings, Layout of building Plan, Types of buildings, Plinth Area, Carpet Area, Super built up area, floor space index, building bye laws, ventilation, components of buildings and their functions, Functional design of buildings, basic concepts of R.C.C., Type of foundations. Surveying:-Principles and types of surveying, Site plans, Linear measurements, Angular measurements, Levelling, ordinary levels and total stations, Use of theodolite and plane table, contouring, L- section and cross sections, Mechanics of Solids:- Forces and Equilibrium, Graphical and analytical treatment of concurrent and non-concurrent co-planer forces, Free body diagram, Analysis of plane truss, Method of joints, Method of sections, Frictional force in equilibrium problems, Centroid and centre of gravity, Moment of inertia of simple and composite areas. Normal stress and strain, Hooke's

law, modulus of elasticity, modulus of rigidity, allowable stress, shear stress and shear strain. Estimation and Costing: Types of estimates and Contracts, Tenders, NIT, EMD and Security deposits, Award of work, measurements, billing and payments.

References:

1. Ramamrutham S., *Basic Civil Engineering* (3e), Dhanpat Rai Publishing Company (P) Ltd, 2013.
2. Punamia B. C., Jain A. K., Jain A. K., *Surveying Volume 1,* (16e), S Chand, 2016.
3. Dutta B. N., *Estimation and Costing in Civil Engineering,* (28e), UBS Publishers Distributors LTD., 2016.
4. Punamia B.C., Jain A. K., Jain A. K*., Building Construction,* (11e), S Chand, 2016.
5. Timoshenko S., Young D.H., Rao J.V., Pati S., *Engineering Mechanics,* (5e), McGraw Hill, 2013.
6. SP41 *Handbook on Functional Design of Buildings*, Bureau of Indian Standards 2013.

CY1002: ENVIRONMENTAL STUDIES [3 0 0 3]

Meaning, multidisciplinary nature of environmental science, applications in engineering disciplines, environmental ethics, sustainable development, Natural (renewable and non-renewable) resources, Resource consumption, Biodiversity and conservation methods, different types of energy, Conventional sources & Non-Conventional sources of energy, Types and Structure of Ecosystem, Environmental Pollution and control, Disaster Management meaning, natural disasters especially earthquakes & Manmade disasters, Environmental Engineering:- Water demand, Water quality standards, basics of water treatment, Conservation of water, Characteristics of sewage, treatment and disposal, Environmental crisis & legislations, Environmental acts, Laws and Policies, EIA, Case studies of the past related to environmental issues, crisis, disasters, hazard, pollution, climate change & its effects, Practical activity related to environmental problems and its impacts on environment.

References:

1. Rajagopalan, R., *Environmental Studies: From Crisis to Cure,* (2e), Oxford University Press, 2016.
2. De, A. K. and De, A. K., *Environmental Studies (2e),* New Age Publishers, New Delhi, 2009.
3. Bharucha E., *Text book of Environmental Studies for undergraduate courses,* (4e), Universities Press, Hyderabad, 2013.

EC1001: BASIC ELECTRONICS [2 1 0 3]

PN Junction: Formation of depletion region, Effect of forward and reverse bias on depletion region, I-V characteristics and equivalent circuits of ideal and practical diode, Diode equation. Application of Diode: Series and parallel combination of diodes circuits, Half Wave and Full Wave rectifiers, capacitor filter, clipper, clamper circuits, Zener Diode; I-V Characteristics, Zener Regulators. BJT: Construction, schematic diagram and characteristic of CE, CB Configuration, CC configuration w.r.t. CE, Relation between α and β, transistor biasing, Q-point, load line, fixed bias, self-bias. Operational Amplifier: Ideal characteristics of an Op. Amp., Inverting and Non-inverting, amplifiers, Linear Circuit applications as voltage follower, integrator, differentiator, summing amplifier, subtractor. Digital Electronics: Number systems, Boolean algebra, De Morgan's Theorem, logic gates; Truth tables, SOP, POS form, K-map for minimization of Boolean expressions, Implementation of Boolean expressions with logic gates, Introduction to combinational & sequential circuits. Communication Systems: Elements of communication systems, Analog modulation scheme.

References:

1. R. L. Boylestad, L. Nashelsky, *Electronic Devices and Circuit Theory*, (10e), Pearson, 2009.
2. S. Salivahanan, S. Arivazhagan, *Digital circuits and Design,* (5e), Oxford University Press, 2018.
3. G. Kennedy, B. Davis, S R M Prasanna, *Electronic Communication systems*, (6e), Mcgraw Hill, 2017.
4. V. K. Mehta, Rohit Mehta, *Principles of Electronics*, (10e), S. Chand Publication, 2006.
5. B. L. Thereja, *Basic Electronics: Solid state*, (5e), S. Chand Publication, 2005

ME1002: ENGINEERING GRAPHICS [0 0 6 3]

Introduction to Engineering Graphics. Principle of Orthographic Projections: Points, straight lines. Straight lines inclined to both HP and VP and its traces. Projections of Planes. Projections of Solids (right regular). Drawing sectional views and true shape of sections. Development of surfaces: Parallel line development, Radial line development. Isometric projections: Plane surfaces and simple solids (prisms & cylinders), Frustum and combination of solids, conversion of isometric to orthographic, Simple machine elements. Introduction to Computer Aided Drafting.

References:

1. Bhatt N.D., *Engineering Drawing*, (53e), Charotar Publishing House, 2014.
2. Bhattacharyya Binoy and Bera S.C., *Engineering Graphics*, I K International Publishing House, 2008.
3. Jolhe Dhananjay, *Engineering Drawing with an Introduction to AutoCAD*, (1e), McGraw Hill Education, 2017.

PY1030: Engineering Physics Lab [0 0 2 1]

Experiments on interference, diffraction and dispersion, experiments on quantum theory of radiation, Experiments on band theory of solids, semiconductors, Experiments on resonance circuits, Hall-effect.

References:

1. Jewett & Serway, *PHYSICS for Scientists and Engineers with Modern Physics* (7e), Cengage Learning, 2008.
2. Worsnop & Flint, *Advanced Practical Physics for Students* (9e), Methuen & Co. Ltd, London 1987.

ME1030: Workshop Practice [0 0 2 1]

Mechanical Engineering Practices: Demonstration and working of Lathe machine with different operations. Study of Arc welding and Spot welding with applications. Preparation of different types of joints on Arc welding and spot welding. Study of two stroke and four stroke engines. Civil Engineering Practices: Layout of a building plan on ground. Levelling by dumpy/tilting level. Measurement of tensile strength of reinforcement bar using UTM. Measurement of compressive strength of Brick/Cement by CTM. Electrical and Electronics Engineering Practices: Designing of residential wiring. Study of three phase induction motor. Study of the working of fluorescent lamp and ceiling fan. Use of electronic Instruments and tools. Building DC Regulated Power Supply.

References:

1. Hajra Choudhury S. K and Bose S. K, *Elements of Workshop Technology*, Vol I, Media Promoters & Publishing Pvt. Ltd., Mumbai, 2012.
2. Raghuvanshi S.S, *Workshop Technology*, Dhanpat Rai and Sons, Delhi, 2002.
3. Punmia B. C, *Surveying*, Laxmi Publications, Bangalore, 2012.
4. Raina K. B., *Electrical Design Estimating and Costing*, New Age International Publishers, 2017.
5. R. L. Boylestad, L. Nashelsky, *Electronic Devices and Circuit Theory*, Tenth edition, Pearson, 2009.

SECOND SEMESTER

MA1201: ENGINEERING MATHEMATICS – II [3 1 0 4]

Differential calculus: curvatures, asymptotes, curve tracing; Partial differentiation, total derivatives, errors and expansions, Taylor's theorem, maxima and minima, Lagrange's method. Infinite series, tests for convergence of series with positive terms, alternating series, power series. Analytical solid geometry- spheres. Cones and cylinders. Multiple integrals and their applications, beta and gamma functions. Laplace transforms, periodic functions, step functions, inverse transforms, convolution, solution of differential equations and applications.

References:

1. Grewal B. S., *Higher Engineering Mathematics*, (42e), Khanna Publishers, 2013
2. Rainville E. D. and Bedient P. E., *A Short Course in Differential Equations* (6e), Macmillan Pub., Mumbai, 1981.
3. Kreyszig E., *Advanced Engineering Mathematics*, (10e), Wiley Eastern, 2011
4. Ramana B. V., *Higher Engineering Mathematics* (6^{th} reprint), Tata Mcgraw-Hill, New Delhi, 2008
5. Iyengar S.R.K. and Jain, Rajendra K. Advance Engineering Mathematics (3e), Narosa book distributors Pvt Ltd-New Delhi, 2007

CY1001: ENGINEERING CHEMISTRY [2 1 0 3]

Theory and application phase rule (up to two component system). Chemistry of primary and secondary batteries. Working principles of fuels cells and their applications. Concept of corrosion and its importance, types of corrosion, factors affecting corrosion, Corrosion control methods. General methods of chemical analysis, Instrumental methods. Introduction to spectroscopic methods of analysis: Electromagnetic radiation (EMR), Interaction of EMR with matter, Numerical Problems. Concepts of rotational, vibrational and electronic spectra, Laws of

spectrophotometry. Classification of Fuels, Gross Calorific value and Net Calorific value. Solid, Liquid and Gaseous fuels. Water treatment technology. Advanced materials and polymers: Liquid crystals, ceramics, composites, bio-materials, nanomaterials, thin films and their properties and applications.

References:

1. Kuriacose J. C. and Rajaram J., *Chemistry in Engineering and Technology*, volume I/II (7e) Tata McGraw - Hill, New Delhi, 2010.
2. Jain P. C. and Jain M., *Engineering Chemistry*, (16e), Dhanpat Rai and Sons, New Delhi, 2015.
3. Fischer T., *Materials Science for Engineering Students*, Academic Press, London, 2009.

EE1001: BASIC ELECTRICAL TECHNOLOGY [2 1 0 3]

DC circuits, Independent sources, Resistance, Network reduction techniques, Mesh and Node voltage analysis, Superposition, Thevenin's and Maximum power transfer theorems, Transient behavior of inductance and capacitance, Self and Mutual inductances, Coupled coils, Dot rule, Average and RMS values of sinusoidal waves, Series and Parallel AC circuits, Phasor Analysis, Power factor improvement, Series and Parallel resonance, Three phase star and delta connected loads, Measurement of power in three phase circuits, Electrical power system, EMF Equation, Construction & Types of Transformers, DC motors, BLDC motors, Induction motors, Synchronous motors, Stepper motors, Fundamentals of Electrical Measuring Instruments.

References:

1. Hughes E., *Electrical and Electronic Technology*, (9e), Pearson Education, 2008
2. Kulshreshtha D. C., *Basic Electrical Engineering*, McGraw Hill, 2012.
3. Kothari D. P. and Nagarath I. J., *Basic Electrical Engineering*, (3e), McGraw Hill, 2016
4. Nagsarkar T. K. and Sukhija M. S., *Basic Electrical Engineering*, (3e), Oxford University Press, 2017

CS1001: PROBLEM SOLVING USING COMPUTERS [2 1 0 3]

Introduction to computing, Importance of Problem solving using computers, Algorithms and Flow charts, Introduction to C language, Simple C programs, Syntax and Logical Errors in compilation, Object and executable code, Variable names and declaration, Data types, Sizes and Constants, Various operators, Type conversion and expressions, Precedence and order of evaluation, Statements and blocks, Control, flow, Break and continue, 1-D and 2-D Arrays and Strings, Searching and Sorting, Multidimensional Arrays and Matrices, Modular programming and Recursive functions, Structure and Pointers, Defining Structures and Array of Structures, Pointer arithmetic, Pointer to Structures, File Management.

References:

1. Dromey. R. G, *How to solve it by computers*, Pearson, 1982.
2. Brian W. Kernighan and Dennis M. Ritchie, *The C Programming language* (2e), Pearson Education, 1988.
3. Deital. P. J and Deitel. H. M, *C: How to program* (7e), Pearson Education, 2010.
4. Balagurusamy, E, *Computing fundamentals and C programming* (1e), McGraw-Hill, 2008.

ME1001: Basic Mechanical Engineering [2 1 0 3]

Working Fluid: Properties of steam, Steam tables, Steam Generators, Classification, Construction and working of Simple boiler. Laws of thermodynamics, Refrigeration and Air Conditioning: Definition, concept, Vapour Compression cycle, C.O.P., working principles and schematic diagrams of Refrigerator, Air Conditioner. Internal Combustion Engine: Classification, Otto and Diesel cycles , Construction and working of SI and CI engine, Two stroke and Four stroke engine, Calculation of thermal efficiency of cycles. Power Transmission: Classification and applications of mechanical drives like belts, ropes, chains and gear drives and their velocity ratios, length of belts, ratio of tensions in belts and ropes, gear train. Machine Tools: Construction, Working and specification of Lathe, Drilling machine and Milling machine. Foundry: Foundry tools and equipment's, Procedure for moulding. Welding: Definition, Gas and Arc welding, Soldering and Brazing. Forging: Definition, applications, tools, Different Forging operations.

References:

1. Mathur, Mehta and Tiwari, *Elements of Mechanical Engineering*, (13e), Jain Brother, 2016.
2. Yunus A.Cengel and Michael A Boles, *Thermodynamics: An Engineering Approach*, (8e), McGraw Hill Education, 2017.
3. Serope Kalpakjian and Steven Schmid, *Manufacturing Engineering and Technology*, (7e), Prentice Hall,

2013.
4. Hajra Choudhury S. K., Hajra Choudhury A.K. and Roy Nirjhar, *Elements of Workshop Technology Vol I & II*, Media Promoters, 2010

LN1001: COMMUNICATION SKILLS IN ENGLISH [2 0 0 2]

Communication: Definition, process, features, types, modes, and barriers; LSRW Skills- Listening: Listening to groups and individuals- active listening, response, and feedback; comprehending conversations and lectures; Reading: Analysis of passages; skimming and scanning; contextual meaning; advanced vocabulary; Writing: Paragraph writing; Writing Creative and Critical responses; Formal letters; Emails; Résumés; Statement of Purpose; Speaking: Presentation, Discussion, and Debate on current affairs, scientific enquiry, philosophical attributions, literary sensibilities, socio-political awareness, and cultural sensitivity; Telephonic Etiquettes; Role Play; Team Work; Time Management; Grooming; Exploring multiple perspectives- critical reasoning, constructive feedback, persuasive arguments, and effective interpersonal communication.

References:

1. Raman M. and Sharma S., *Technical Communication: Principles and Practice*, (2e), Oxford University Press, 2013.
2. Krishnaswamy N., *Modern English: A Book of Grammar Usage and Composition*, Macmillan India, 2018.
3. Kumar Sanjay and Pushplata, *Communication Skills*, Oxford University Press, 2016.
4. Mishra S. and Muralikrishna C., *Communication Skills for Engineers*, Pearson, 2014.

CS1030: PROBLEM SOLVING USING COMPUTERS [0 0 2 1]

Introduction to Computing, Simple C programming, Branching Control Structures, Looping Control Structures, 1D and 2D Array programming, String programming, Modular and Recursive Function Programming – Programs using Pointers, Structures and File manipulation.

References:

1. Brian W. Kernighan and Dennis M. Ritchie, *The C Programming language,* (2e), Pearson Education, 1988.
2. Deital. P. J and Deitel. H. M, C: *How to program,* (7e), Pearson Education, 2010.
3. Balagurusamy. E*, Computing fundamentals and C programming,* (1e), McGraw-Hill, 2008.
4. Duane Hanselman and Bruce Littlefield, *Mastering Matlab 7*, Pearson Publication, 2008.
5. Stormy Attaway, *Matlab: A practical Introduction to Programming and Problem Solving*, Elsevier, ISBN: 978-0-75-068762-1.

CY1030: ENGINEERING CHEMISTRY LABORATORY [0 0 2 1]

Alkalimetric titration; Redox titration; Estimation of total hardness of water; pK value of an acid by pH-metric titration; Conductometric acid base titrations; pH Metric acid base titrations; Synthesis of a resin; Determination of coefficient of viscosity of liquid; Determination cloud and pour point of a given sample of lubricating oil using cloud and pour point apparatus; Determine the water equivalent of bomb calorimeter using benzoic acid as fuel.

References:

1. Nad A. K., Mahapatra B., and Ghoshal A., *An Advanced Course in Practical Chemistry* (8e), New Central Book Agency, 2017.
2. Mangla B., Sachdeva R., and Sethi B., Engineering Practical Chemistry, (2e), Manakin press, 2018

DA1001: Experiential Learning [0 0 4 2]

The course will be conducted by various engineering departments and will facilitate branch specific experience based learning for students.

Department of Automobile Engineering

The Department of Automobile Engineering was established in 2012 with the objective of offering world-class quality education through updated curriculum to meet the changing requirements of automotive industry. Department offer UG and Doctoral Programs. Department is equipped with well qualified faculty and state-of-art infrastructure, preparing graduates to contribute to the society with technically and commercially viable solutions. The faculty is actively involved in research and development of alternative fuels, nanomaterials for automotive tyres and battery system for electric vehicles. The department has MoU with BOSH and Automotive Skill Development Council, India for skill certification to increase employability of our students. The department has MoU with ESTACA, University in Paris which provide opportunity to study VI semester in France with tuition fee waiver. Department has vibrant student clubs such as SAE India and Road Safety Club in which students design and build vehicles in-house to showcase their talent in SAE competitions such as BAJA, Effi Cycle, Electromove and Supra and the students have won various awards at national level. The students of our department annually organizes national level motor sports car racing event in the campus approved by federation of motor sports club of India to understand technicality of sports cars and the art of high-speed driving & off.



B.Tech in Automobile Engineering
(Course Structure & Syllabus III Semester Onwards)

YEAR	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value Ethics & Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA21XX	Engineering Mathematics-III	3	0	0	3	MA22XX	Engineering Mathematics-IV	3	0	0	3
	AU2101	Material Science and Metallurgy	3	0	0	3	AU2201	Automotive Chassis System	3	0	2	4
	AU2102	Strength of Materials	3	1	0	4	AU2202	Kinematics and Dynamics of Automobile	3	1	0	4
	AU2103	Theory of Automotive Engines	3	1	0	4	AU2203	Fluid Mechanics	3	0	0	3
	AU2104	Engineering Thermodynamics	3	1	0	4	XXXXXX	Open elective-I	3	0	0	3
	AU2130	Automotive Engines Lab	0	0	2	1	AU2230	Computer Aided Drawing Lab	0	0	4	2
	AU2131	Strength of Materials Lab	0	0	2	1	AU2231	Fluid Mechanics Lab	0	0	2	1
	AU2170	Seminar	0	0	2	1	AU2270	Project Based Learning-I	0	0	2	1
			17	3	6	23			18	1	10	24
	Total Contact Hours (L+T+P)		26				Total Contact Hours (L+T+P)+OE		29			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	BB0026	Organization & Managment	3	0	0	3	AU3201	Heat transfer	3	1	0	4
	AU3101	Automotive Transmission Systems	3	0	2	4	AU3202	Electric and Hybrid vehicle	3	0	0	3
	AU3102	Manufacturing Technology	3	0	2	4	AU3203	Quality Assurance and Reliability Engineering	3	1	0	4
	AU3103	Automotive Design	3	0	0	3	AU32XX	Program Elective-I	2	0	2	3
	AU3104	Automotive Electrical and Electronics Systems	3	1	0	4	AU32XX	Program Elective-II	2	0	2	3
	XXXXX	Open elective-II	3			3	XXXXXX	Open elective-III	3	0	0	3
	AU3130	Automotive Design Lab	0	0	2	1	AU3230	Computer Integrated Manufacturing lab	0	0	2	1
	AU3131	Automotive Electrical and Electronic Systems Lab	0	0	2	1	AU3231	Vehicle Dynamics Simulation Lab	0	0	2	1
	AU3170	Project Based Learning-II	0	0	2	1	AU3232	Automotive Control Systems Lab	0	0	2	1
							AU3270	Project Based Learning-III	0	0	2	1
			18	1	10	24			16	2	12	24
	Total Contact Hours (L+T+P)+OE		29				Total Contact Hours (L+T+P) +OE		30			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	AU41XX	Program Elective-III	2	0	2	3	AU4270	Major Project	0	0	0	12
	AU41XX	Program Elective-IV	2	0	2	3						
	AU41XX	Program Elective-V	2	0	2	3						
	AU41XX	Program Elective-VI	2	0	2	3						
	AU41XX	Program Elective-VII	2	0	2	3						
	AU4170	Minor Project using Lean Six Sigma	0	0	4	2						
	AU4171	Industrial training	0	0	2	1						
			10	0	16	18			0	0	0	12
	Total Contact Hours (L+T+P)		26				Total Credit= 169(including first year)					

THIRD SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications.

AU2101: MATERIAL SCIENCE AND METALLURGY [3 0 0 3]

Introduction: Materials classification, Crystallography. Miller indices: Miller Bravais indices, Crystal structure determination. Imperfections in Crystals: Point defects, Line defects, Surface defects, Plastic Deformation, Metals and Alloys, Dislocation, Slip and twinning, Schmid's law. Strengthening mechanisms: Solid solution strengthening, Work hardening, Recovery recrystallization and grain growth. Diffusion: Steady state and non-steady state diffusion. Solidification of Metals and Alloys: Solid solution, Hume-Rothery rules, Phase diagrams Phase and Lever Rules relationship of micro Structure and properties, Isomorphs systems, Eutectic system, Eutectoid Peritectoid reactions, Iron- Carbon equilibrium diagram, Development of microstructure in Iron Carbon alloys, Phase transformation in steel, Heat Treatment ,TTT diagram. Steel: Low, medium, and high carbon steels, Stainless steels-ferrite, Austenitic, Martensitic, Duplex steels, Tool steels, Aluminum and its alloys, Magnesium and alloys, Titanium and its alloys. Other materials: Super alloys, ceramics, Refractories, Composites and glasses, Nano-materials.

References:

1. R Balasubramaniam, *Callister's Materials Science and Engineering*, (2e), Wiley India, 2010.
2. R Abbaschian, E Robert, *Physical Metallurgy Principles*, (4e), Cengage Learning, 2009.
3. V Raghavan, *Material science and engineering*, (6e), Prentice Hall India, 2015.
4. J F Shackelford, *Introduction to Materials science for Engineers*, (8e), Pearson, 2014.
5. A Sidney, *Introduction to physical metallurgy*, (2e), Tata McGraw Hill, 2017.

AU2102: STRENGTH OF MATERIALS [3 1 0 4]

Stresses and Strains: Overview of simple stresses and strains, Principal stresses and strains, Mohr's circle. Shear Force and Bending Moment: Bending moment and shear force diagrams for different types of static loading and support conditions on beams. Strain Energy: Strain energy stored in the member due to various types of loading. Pure bending and Shear stress in beam: Theory of simple bending, bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Torsion: Torsion of circular shafts – solid and hollow, stresses in shaft when transmitting power, shafts in series and parallel. Column and strut: Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine formula and other empirical relations. Deflection of Beam: Deflection of beam for different types of loadings. Thick and Thin cylindrical shells and spherical shells.

References:

1. S Timoshenko, *Strength of materials*, Vols. I (3e), CBS publications, 2014.
2. A Pytel, F L Singer, *Strength of Materials*, (4e), Harper & Collons, 2011.
3. F P Beer, E R Johnston, *Vector for Mechanics of Engineers*, (9e), Tata McGraw Hill, 2010.
4. S S Ratan, *Strength of Materials*, (3e), Tata McGraw-Hill, 2016.

AU2103: THEORY OF AUTOMOTIVE ENGINES [3 1 0 4]

Engine classifications, 4 stroke engine - Constructional details, working principle. Cylinder layout and configurations. Firing order and its significance. Engine balancing. Fuel feed system of gasoline and diesel engines Carburettor – requirements, working principle, types, different circuits – Compensation & Maximum power devices – Petrol injection in SI engines, FIP'S, CRDI, Magneto coil and battery coil spark ignition system. Electronic ignition System – CDI. Need for cooling. Types of cooling system – air cooling and Liquid cooled systems. Forced circulation system, pressure cooling system, Evaporative cooling system – Need for Lubrication system. Mist lubrication system, wet & dry sump lubrication. Two stroke engine – types, terminologies, definitions, construction and operation. Comparison of four stroke and two stroke engine operation. Theoretical scavenging processes. Merits and demerits, scavenging efficiency, Scavenging pumps, Supercharging and turbocharging, Combustion in SI & CI Engines – Introduction, Pressure Crank angle diagrams, Factors affecting combustion, Knocking in SI & CI Engines, Special type of engines like wankel, free piston, lean burn, Stratified charged & HCCI Engines

References:

1. J B Heywood, *Internal Combustion Engine Fundamentals*, (India Edition), McGraw Hill Publishers, 2011.
2. V Ganesan, *Internal Combustion Engines*, (4e), McGraw Hill, 2011.
3. K K Ramalingam, *Internal Combustion Engines*, (3e), Scitech Publishers, 2017.

AU2104: ENGINEERING THERMODYNAMICS [3 1 0 4]

Basic Concepts: Systems, Control Volume, Surrounding, Universe, Macroscopic and microscopic viewpoints, Concept of continuum, Thermodynamic equilibrium, State, Properties, Processes, Cycle, Reversibility, Causes of irreversibility, Energy in state and in transition, Work and heat, Point and path function. Laws of Thermodynamics: Zeroth Law of Thermodynamics, First Law of Thermodynamics for flow and non-flow processes, Second Law of Thermodynamics, Elementary Treatment of the Third Law of Thermodynamics. Entropy: Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase. Refrigeration Cycles: Brayton and Rankine cycles – Performance evaluation, combined cycles, Bell Coleman cycle, Vapour compression cycle, Performance evaluation.

References:

1. C Borgnakke, R E Sonntag, *Fundamentals of Thermodynamics*, (7e), John Wiley Pub, 2009.
2. Y Cengel, Boles, *Thermodynamics – An Engineering Approach*, (7e), TMH, 2000.
3. P k Nag, *Engineering Thermodynamics*, (6e), Tata McGraw Hill, 2017.

AU2130: AUTOMOTIVE ENGINES LAB [0 0 2 1]

Study of Special engine tools, equipment and safety, Assembling and Dismantling of single cylinder, multi cylinder engines, 2 stroke engine, valve & port timing. Performance testing on single cylinder, multi cylinder petrol & diesel engines, heat balancing, VCR engine performance test, FIP calibration test Engine tuning and overhauling.

References:

1. J B Heywood, *Internal Combustion Engine Fundamentals*, (India Edition), McGraw Hill Publishers, 2011.
2. V Ganesan, *Internal Combustion Engines*, (4e), McGraw Hill, 2011.

AU2131: STRENGTH OF MATERIALS LAB [0 0 2 1]

Introduction-Tensile test using UTM, load displacement and Stress Strain curves, Torsion Test, Compression Test, Bending Test, Impact test: Izode and Charpy Test, Hardness Test: Brinell and Rockwell test, Fatigue and Shear Test, Test on Helical Spring.

References:

1. E P Popov, *Engineering Mechanics of Solids*, PHI, 2004.
2. N E. Dowling, *Mechanical Behaviour of Materials*, Pearson Education, 2010.

AU2170: SEMINAR [0 0 2 1]

Each student has to present a seminar on any technical topic. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/ question & answers; The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance; Each student has to submit a seminar report to the department at least three days before the day of seminar; Each student has to make the power point presentation (PPT).

FOURTH SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behavior, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

AU2201: AUTOMOTIVE CHASSIS SYSTEM [3 0 2 4]

Automotive chassis and frames, functions, requirements, classification. New techniques in chassis design, Braking systems: requirements, principle of operation, classification, different types of vehicle brakes, and mechanics of brakes. Steering systems: condition for true steering, steering linkages, and power steering. Suspension systems: classification, functions, rigid and independent suspension systems. Automotive wheels and tyres. Lab: Dismantling and assembling of different types of braking systems, steering systems and suspension systems. Wheel balancing and alignment.

References:

1. K Newton, W Steeds, T K Garrett, *The Motor Vehicle*, SAE Publications, 2004.
2. J I Heintner, *Automotive mechanics principles and practice*, CBS Publishers and distributors, 2004.
3. T R Banga, N Singh, *Automobile Engineering*, Khanna Publishers, 2007.
4. R K Rajput,, *Automobile Engineering*, Laxmi Publications Ltd, 2008.

AU2202: KINEMATICS AND DYNAMICS OF AUTOMOBILE [3 1 0 4]

Mechanism and inversions. Degrees of freedom. Mathematical analysis of velocity and accelerations of simple mechanisms. Synthesis of cams and gears. Gear trains. Static and dynamic force analysis of linkages. Balancing of rotating and reciprocating masses. Governors and its characteristics. Gyroscope and gyroscopic effect on automobiles, Hooks joint.

References:

1. J J Uicker, G R Pennock, J E Shigley, *Theory of Machines and Mechanisms*, Oxford University Press, 2011.
2. A Gosh, A K Malik, *Theory of Mechanisms and Machines*, East West Publishers, 2006.
3. J S Rao, R V Dukkipati, *Mechanisms and Machines Theory*, New Age Int.., 2007.
4. S S Rattan, *Theory of Machines*, Tata Mc Graw Hill, 2008.

AU2203: FLUID MECHANICS [3 0 0 3]

Fundamentals: Definition and properties of fluids, intensity of pressure, variation of pressure in a static fluid, Manometers. Fluid statics: Hydro static forces and centre of pressure on plane surfaces, Buoyancy, centre of Buoyancy, Meta-centre and Meta-centric height, Stability of floating and sub-merged bodies. Kinematics and Dynamics of fluid flow: Types of fluid flow, continuity equation, one dimensional Euler's equation of motion, Bernoulli's energy equation. Fluid flow measurements: Pitot tube, orifice meter, venture meter and notch. Viscous flow: Reynolds Number, laminar flow through circular pipe, laminar flow between fixed parallel plates. Fluid flow in pipes: Losses in pipes, Minor and major losses, Darcy and Chezy equations. Dimensional analysis and Similitude: Methods of dimensional analysis, similitude. Pneumatic & Hydraulic valves: Construction and working of various types of direction control, pressure control, flow control valves, servo valve, proportional valve, accumulator. Hydraulic & Pneumatic circuits: Regeneration, meter in, meter out, bleed off, sequencing, counter balancing, pressure reducing and typical application circuits.

References:

1. Y Cengel, J M Cimbala, *Fluid Mechanics*, Tata Mcgraw-Hill Publications, New Delhi, 2013.
2. F N White, *Fluid Mechanics*, Tata Mcgraw-Hill Publications, New Delhi, 2011.
3. B R Munson, T H Okiishi, W W Huebsch, A P Rothmayer, *Fundamentals of Fluid Mechanics*, John Wiley and Sons, New Jersey, 2013.
4. C T Crowe, D F Elger, B C Williams, J A Roberson, *Engineering Fluid Mechanics*, John Wiley and Sons, New Jersey, 2009.

AU2230: COMPUTER AIDED DRAWING LAB [0 0 4 2]

Introduction: CAD software and its applications. Software: Auto CAD and Creo. GD & T: Introduction to GD & T, part features, symbols, screw threads, gears and splines, basic dimension, limits, fits & tolerances, Datum and plane. 2D Part Drawing using Auto – CAD. 3D Part modelling using Creo – exercises on modelling of automotive components.

Reference:

1. A Krulikowski, *Fundamentals of Geometric Dimensioning and Tolerancing*, International edition, Delmar Cengage Learning, 2012.
2. G Omura, B C Benton, *Mastering AutoCAD 2013*, serious skill, 2012.

AU2231: FLUID MECHANICS LAB [0 0 2 1]

Flow Measuring Devices, Pneumatic and Hydraulic actuators: Linear Actuator- single acting & double acting cylinder, rotary actuator- gear, vane and piston pump. Pneumatic and Hydraulic valves: direction control, pressure control and flow control valves, servo valves, proportional valves. Hydraulic trainer, Pneumatic trainer.

References:

1. A Esposito, *Fluid Power with Applications*, (7e), Prentice-Hall International, 2008.
2. I Sivaraman, *Introduction to Hydraulics and Pneumatics*, (3e), PHI Learning Pvt. Ltd., 2017.
3. Y Cengel, J Cimbala, *Fluid Mechanics,* (3e), McGraw Hill Education, 2017.

AU2270: PROJECT BASED LEARNING I [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

FIFTH SEMESTER

AU3101: AUTOMOTIVE TRANSMISSION SYSTEMS [3 0 2 4]

Power Required for Propulsion: Resistances to Motion of the Automobile, Traction, tractive effort, Performance curves, acceleration, gradeability, drawbar pull, Numerical Problems. Clutch: Types of clutches, construction and operation of all types, Numerical problems. Gear box: Performance characteristics in different gears, Desirable ratios of 3speed and 4speed gear boxes, Constructional details of different types of gear boxes, Propeller shaft, Differential. Fluid Coupling and Torque converters: Constructional details, performance characteristics, slip, principles of torque multiplication, 3 and 4 phase torque converters, typical hydrodynamic transmission. Epicyclic Transmission: Principle of operation, types of planetary transmission, Calculation of gear ratio in different speeds, Hydrostatic Drives: Principles of hydrostatic drives, different systems of hydrostatic drives, construction and operations. Automatic and Electric Transmissions: Construction and operation. Lab: Overhaul, routine service , diagnosis and repair of - Clutches, Gear boxes, Transfer box, Universal joint, Constant Velocity joints, Propeller shafts, Differential mechanisms with differential lock and non-slip differential, Types of drive axles, Hydrostatic drive, Hydrodynamic drive- torque converter.

References:

1. K. Singh, *Automobile engineering* Vol.1, Standard Pub, 2012.
2. G.B.S.Narang, *Automobile Engineering*, Khanna publication, New Delhi, 2008.
3. N. Tesla, *Transmission of Power: Polyphase System*, reprint, Forgotten Books, 2018

AU3102: MANUFACTURING TECHNOLOGY [3 0 2 4]

Foundry: Patterns, Molding, Sand casting, Permanent mold casting, Centrifugal casting, Investment casting, Continuous casting, cleaning and casting defects. Metal Forming: Forging, Rolling, Extrusion, Drawing. Sheet Metal Working: Cold, warm and Hot working, Operations and Dies. Welding: Classification, Resistance welding- spot, seam, projection, Arc welding - Metal Arc, TIG, MIG, Submerged Arc, Electro-slag, Friction welding, welding defects. Machining: Single point and multi point cutting tools terminology, Construction, working principle and operations of Machine tools- lathe, milling, drilling, grinding, Introduction and applications of shaper, and planer, Gear manufacturing- milling, hobbing, shaping. CNC machining: Introduction, Classification, sample part programming on Turning and Milling centers, Non-conventional Machining: Working principle, applications, advantages and limitations of Abrasive water jet machining, Electric discharge machining, Ultrasonic machining, Laser beam machining, Electron Beam Machining. Processing of plastics: Extrusion, Injection and Blow molding, Powder metallurgy – steps and applications, Additive manufacturing: Rapid proto typing, Fused Metal Deposition, 3D printing, Production tooling – Jigs and fixtures, principle of location and clamping. Case studies of manufacturing of automotive components.

Lab: Model preparation using foundry, forging and welding techniques. Preparation of turning Models involving common operations using Lathe. Spur gear and helical gear cutting using milling machine. Practice on shaping and grinding machines. Demonstration of machining on CNC turning & milling centers and use of Non-conventional machines.

References:

1. P N Rao, *Manufacturing Technology Vol. I*, (5e), Tata McGraw-Hill, 2018.
2. P N Rao, *Manufacturing Technology Vol. II*, (4e), Tata McGraw-Hill, 2018.
3. S Kalpakijian, S R Schmid, *Manufacturing Engineering and Technology*, (7e), Pearson Education, 2013.
4. M P Groover, *Fundamentals of modern manufacturing, Materials, Processes, and Systems*, (6e), John Wiley, 2015.
5. P Degarmo, Black, Kohser, *Materials and Processes in Manufacturing*, (12e), Wiley, 2017.

AU3103: AUTOMOTIVE DESIGN [3 0 0 3]

Introduction: Auto Design, Various Aspects, Classification, Requirements, general procedure of design, principles of design optimization, Brain storming. Design of flywheel: Determination of the mass of a flywheel for a given co- efficient of speed fluctuation. MI of flywheel, Engine flywheel - stresses on the rim of the flywheels. Design of hubs and arms of the flywheel, turning moment diagram. Design of Engine Components: Design of various cylinder heads and cover plates Design of piston, piston pin, piston rings and their materials, design of connecting rod and its material. Design of crank shaft, crankshaft materials, Design considerations of valve design, intake and exhaust valve design. Design of rocker arm. Design of Brakes: Drum and Disc brakes. Design of Suspension Spring: Design of laminated leaf spring and coil spring. Design of Gears and Gear boxes: Design consideration- Strength of gear teeth, Lewis equation- Dynamic tooth load. Design of Spur Gear and helical gears.

References:

1. R L Norton, *Machine Design: An Integrated Approach*, (4e), Pearson, 2010.
2. J Shigley, *Mechanical Engineering Design*, McGraw Hill New York, 2016.
3. M F Spotts, E T Shoup, L E Hornberger, *Design of Machine Elements*, (8e), Pearson 2003.
4. V B Bhandari, *Design of Machine Elements*, (4e), Tata McGraw Hill Publishing Company, 2017.
5. V B Bhandari, *Machine Design Data Book*, Tata McGraw Hill Publishing Company, 2014.

AU3104: AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS [3 1 0 4]

Automotive starter batteries: Functional requirements, operating principle, Pb-acid battery characteristics, maintenance and troubleshooting. Starting System: overview. Starter motor – construction, working principle and circuit, characteristics, maintenance, Integrated Starter Generator systems. Alternator- operating principle, charging circuit, characteristics curves, design, control, relays, voltage regulation. Ignition system: Types, construction & working, Centrifugal and vacuum advance mechanisms, Types and construction of spark plugs, Vehicle wiring circuits, electrical loads, harness, connectors, earthing, electrical safety procedures, Electronic components in vehicles, Electronic Control units, Sensors – measuring principles, sensor types. Actuators- working principles, types. Electromagnetic compatibility (EMC) and interference, Automotive networking.

References:

1. R BOSCH Gmbh., *Bosch Automotive Electrics and Automotive Electronics*, (5e), Springer Vieweg (eBook), 2007.
2. W B Ribbens, *Understanding Automotive Electronics*, (7e), Butterworth-Heinemann (Elsevier), 2012.
3. T Denton, *Advanced Automotive Fault Diagnosis*, (4e), Routledge, 2017.

AU3130: AUTOMOTIVE DESIGN LAB [0 0 2 1]

Introduction to 2D entities, Mechanical Components, Automotive components, Introduction to 3D Entitles, Introduction to Assembly commands, Automotive Components assembly, Rocker Arm Assembly, IC Engine Connecting rod, Engine Cross Head, Screw Jack using design software.

References:

1. S Tickoo, *CATIA V5R17 for engineers & Designers*, Dreamtech Press Publication, 2008.
2. M Michaud, *CATIA Core Tools: computer aided three-dimensional interactive application*, McGraw Hill Professional Publication, 2012.
3. K Plantenberg, *An Introduction to CATIA V6 Release 2012*, Schroff Development Publication, 2011.

AU3131: AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS LAB [0 0 2 1]

Use of electrical and electronic testing & measurement equipment digital multi meter, battery testing for state of charge in-vehicle & outside, battery load testing, hydrometer testing, servicing, charging. Testing, servicing, dismantling, assembly, inspection of Alternator and Starter motor. Electrical wiring diagrams, connectors, fuses, electrical load calculations, identification and replacement of faulty components. Computer based diagnostic equipment: Use of On Board Diagnostic kit for scanning ECU, data scanners, test lights, test LEDs, pulse generators etc. Use of Digital Storage Oscilloscope for diagnosis of voltage, current, sensor outputs. Verifying logic gates (OR, AND,NAND,NOR,EX-OR,NOT) ,characteristics of Full wave rectifier, square wave form in 555 TIME, Characteristics of Thermocouple, Thermistor, Hall effect transducer and inductive pickup, Resistive Temperature Detector, DC servo motor speed control system, programming on microcontroller, interfacing of peripherals.

References:

1. Al Santini, *Bosch Automotive Electricity and Electronics*, (2e), Delmar Cengage, 2013.
2. T Martin, *How to Diagnose and Repair Automotive Electrical Systems*, Motorbooks, 2005.

AU3170: PROJECT BASED LEARNING II [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SIXTH SEMESTER

AU3201: HEAT TRANSFER [3 1 0 4]

Introduction: Various modes of heat transfer, conductivity and film coefficient of heat transfer, Thermal diffusivity, overall heat transfer coefficient, thermal resistance and conductance. Heat Transfer by conduction: General heat conduction equation ,Linear heat flow through Plane Wall, Composite Walls, radial heat flow through cylinder, Composite Cylinders, Sphere and Composite spheres, critical thickness of insulation. Heat Transfer from Extended Surfaces: Heat transfer from fins of uniform cross section heated at one end or both ends, Efficiency and effectiveness of fin. Heat Transfer by convection: Free and forced convection heat transfer. Heat Transfer by Radiation: Thermal radiation, absorption, reflection and transmission of radiation, Kirchhoff's Law. Wien's displacement Law, Stefan Boltzmann's law, Intensity of radiation, Lambert's cosine law. Heat Exchangers: Classification of heat exchanger. Analysis using LMTD, Effectiveness-NTU Method, fouling mechanism, growth and design to minimize fouling. Heat transfer in IC engines: Radiator construction, Engine Cooling system construction, coolant properties. Design parameters for radiator & water pump design, hoses, Thermostat Valve, Radiators Cap, Radiator fan, Radiator Fan shroud, Surge Tank.

References:

1. P K Nag, *Heat and Mass Transfer*, Tata Mcgraw Hill Education Pvt Ltd, 2011.
2. Y Cengel, A Ghajar, *Heat and Mass Transfer*, Tata Mcgraw Hill Education Pvt Ltd, 2001.
3. S K Som, *Introduction to Heat Transfer*, PHI Learning Pvt Ltd, 2008.
4. V Ganesan, *Internal Combustion Engines*, Tata Mcgraw-hill Education, 2012.

AU3202: ELECTRIC AND HYBRID VEHICLES [3 0 0 3]

Fundamentals of Vehicle Propulsion, vehicle resistances, powertrain characteristics, vehicle performance, braking, tires. Batteries- Types, Parameters, Capacity, Charge / Discharge rate, SOC, DOD, Battery pack Design, Safety issues and hazards. Overview of Electric vehicles - Hybrid Electric vehicles architectures, Types – series, parallel, mild, complex configurations, Plug in hybrid electric vehicle – Design – Drive train, sizing of components. Vehicle simulation (simulation model, standard drive cycles). Electric Machine fundamentals (motional voltage, EMF), simple DC machines (induced voltage, force and torque, DC machine back emf and torque, simple reluctance motor). DC machines, Three phase AC machines. Induction machines. Permanent magnet machines. Switched reluctance machines. Power electronic switches. DC/DC converters. Case studies on EVs and HEVs, Components of DC and AC Charging System for vehicle, Fast Charging, Ultra-Fast charging systems.

References:

1. J D Haldeman, *Hybrid and Alternative Fuel Vehicles*, (2e), Pearson. Education, 2012.
2. I Hussain, *Electric and Hybrid Vehicles: Design Fundamentals*, (2e), CRC Press, 2010.
3. A E Fuhs, *Hybrid Vehicles and the Future of Personal Transportation*, CRC Press, 2009.
4. J German, *Hybrid powered Vehicles*, (2e), SAE International, 2011.

AU3203: QUALITY ASSURANCE AND RELIABILITY ENGINEERING [3 1 0 4]

Introduction to Quality: Definition of quality control, quality assurance, quality audit, dimensions of quality, seven quality tools, type of quality costs, cost of poor quality (COPQ) calculation methodology, General quality control engineering fundamentals. Total Quality Management: Philosophies of quality - Deming, Juran and Crosby, Scope and Principles of TQM, Kaizen teams, Quality Circles, Strategic quality management. Introduction to Statistical Quality Control: Control charts for variables and attributes, process capability. Reliability: Concepts of reliability, Quality and Reliability, Methods of Estimating of Reliability, Field Failure Data Analysis, Failure Rate, Failure Density, Life testing, MTBF, MTTF, Maintainability & Availability, Reliability Allocation - Series Systems, Parallel Systems, Combined Series and parallel Systems. Block Diagrams, Fault tree analysis, Event tree analysis, Design review and validation, Design for reliability.

References:

1. H Gitlow, R Oppenheim, A Oppenheim, D Levine, *Quality Management*, McGraw Hill Education, 2017.
2. E L Grant and R Leavenworth, *Statistical Quality Control*, (7e), McGraw Hill Education, 2017.
3. D C Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley and Sons, New York, 2009.
4. C E Ebeling, *An Introduction to Reliability and Maintainability Engineering*, (8e), Tata McGraw-Hill, 2007.

AU3230: COMPUTER INTEGRATED MANUFACTURING LAB [0 0 2 1]

CNC part programing for turning and milling applications, CAM software for simulation and generate cutter location data from CAD models, function and programming for pick and place robot.

Reference:

1. M P Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Prentice Hall of India, 2008.

AU3231: VEHICLE DYNAMICS SIMULATION LAB [0 0 2 1]

Use of ANSYS Workbench for simulation of Vehicle Dynamic problems. Modelling of components using Design Modeller, Mesh generation, aerodynamic simulation of flow over NACA airfoils, flow in a pipe, aerodynamic drag simulation of a car. Crash Simulation of car, simulation of spring suspension, simulation of alloy wheel.

References:

1. *ANSYS Workbench User Manual*.
2. T Martin, *How to Diagnose and Repair Automotive Electrical Systems*, Motorbooks, 2005.

AU3232: AUTOMOTIVE CONTROL SYSTEMS LAB [0 0 2 1]

Introduction to MATLAB Programming: Basic Operations, vectors, Elementary MATLAB Constructs, Loops and Conditional Statements, Writing Scripts and Functions, 2-D, 3-D Plotting, Polynomial Evaluation, Importing Data, Solution of Differential Equations, Introduction to Simulink: Operating Principle and Solving problems with Simulink, Automotive control system design simulations - Spark-timing control, hybrid vehicle drive cycle, control of fuel cells, Adaptive PI Cruise controller design, Anti-lock braking system controller.

References:

1. A G Ulsoy, H Peng, M Cakmakci, *Automotive Control Systems*, (1e), Cambridge University Press, 2012.

2. A Gilat, *MATLAB-An Introduction with Applications*, Wiley India, 2009.
3. S.J.Chapman, *Programming in MATLAB for Engineers*, Cengage Learning, 2011.

AU3270: PROJECT BASED LEARNING III [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SEVENTH SEMESTER

AU4170: MINOR PROJECT USING LEAN SIX SIGMA [0 0 4 2]

Complete a project by applying Lean Six Sigma methods to Define, Measure, Analyze, Improve and Control the deliverables. DEFINE tools will include – Project Chartering, Project Planning and Management. MEASURE tools will include: establishing baseline to measure improvement, process Mapping, SIPOC, Value Stream Mapping to identify Value Add and Non-Value Add work, Spaghetti diagrams. Measurement System Analysis (MSA), Gage R&R ANALYSIS tools will include: Cause & Effect analysis, FMEA, Process capability analysis and process control (SPC) using Minitab, verify critical inputs using DOE with Minitab. IMPROVEMENT tools will include – establishing single piece flow using Kanban / Pull methods that are trigged by customer demand, Mistake Proofing, Quick Changeover, Workplace Organization, Process Mapping, Process Documentation, piloting a new process to test for improvement. The Control Phase tools and methods will develop a control system to ensure long term sustainability using - Control Plans, Process Documentation, Training Plans, Statistical Process Control and Process Capability.

References:

1. M L George, J Maxey, D T Rowlands, M Upton, *Lean Six Sigma*, McGraw-Hill Education India, 2004.
2. S Shaffie, S Shahbazi, *The McGraw-Hill 36-Hour Course: Lean Six Sigma*, McGraw-Hill 2012.

AU4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a period of 4-6 weeks. This may be taken in a phased manner during the vacation starting from the end of six semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

EIGHTH SEMESTER

AU4270: MAJOR PROJECT [0 0 0 12]

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry/ research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be on the basis of the total marks obtained by him/ her out of 400 marks. There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken. The final evaluation and viva voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

PROGRAM ELECTIVE- I

AU3240: ADVANCED INTERNAL COMBUSTION ENGINES [2 0 2 3]

Theory of SI and CI engine combustion – Flame velocity and area of flame front. Fuel spray characteristics – droplet size, depth of penetration and atomization, Combustion analysis in IC engines: Photographic studies of combustion processes – Analysis of Pressure crank angle diagrams in SI and CI engines. Knock study for Pressure crank angle histories. Apparent heat release rate and Wiebe's law analysis for combustion. Calculation of Ignition delay and combustion duration. – Hot wire and laser Doppler anemometry and velocimetry for flow and combustion analysis in IC engines. Combustion of fuels: Chemical composition and

molecular structure of hydrocarbon fuels. Combustion Stoichiometry of hydrocarbon fuels – Chemical energy and heat of reaction calculations – Chemical equilibrium and adiabatic flame temperature calculation. Lab: Combustion Analysis experiments on SI & CI engine by varying CR, Injection Timing, Injection Pressure and blending of fuels. FIP calibration test.

References:

1. J B Heywood, *Internal Combustion Engine Fundamentals*, (India Edition), McGraw Hill Publishers, 2011.
2. V Ganesan, *Internal Combustion Engines*, (4e), McGraw Hill, 2011.
3. K K Ramalingam, *Internal Combustion Engines*, (3e), Scitech Publishers, 2017.

AU3241: VEHICLE BODY ENGINEERING [2 0 2 3]

Car Body: Types of car bodies, limousine, estate car, racing and sports car. Visibility: Regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars. Safety: Safety design, safety equipment for cars. Car body construction: Design criteria, prototype making, initial tests, crash tests on full scale model, Dummies and Instrumentation. Vehicle Aerodynamics; Objectives. Vehicle drag and types; various types of forces and moments, effects of forces and moments, side wind effects on forces and moments, Various body optimization techniques for minimum drag. Wind tunnel testing: Flow visualization techniques, scale model testing, component balance to measure forces and moments. Bus Body: Types, layout, entrance, exit and seating dimensions. Constructional details: Frame construction, double skin construction, types of metal sections used, Regulations, Conventional and integral type construction. Commercial Vehicle body: Classification, Dimensions of driver's seat relation to controls, Drivers cab design.

Lab: Visibility test, types of tool used, welding process on vehicle body penal, Mechanisms of Door lock , Window winding and Driver seat, Dent removal process, Painting processes, Scale models- Bus body, Mini truck, and cars, Wind tunnel test.

References:

1. J E Duffy, *Body Repair Technology for 4-Wheelers*, Cengage Learning, 2009.
2. D Anselm, *The passenger car body*, SAE International, 2000.
3. J Powloski, *Vehicle Body Engineering*, Business Books Ltd., 1998.

AU3242: COMPUTER INTEGRATED MANUFACTURING AND ROBOTICS [2 0 2 3]

Computer integrated manufacturing system, N.C. Machine tools- classification, working, design considerations, construction requirements, machine accuracy and productivity. Control loops of NC systems, G & M codes for NC and CNC machine, ATC, Co-ordinate systems, point to point and contour programming, conventional NC, interactive graphics, manual data input, Adaptive Control System, Programmable Logic Controller. Industrial robots-Robot anatomy, physical configurations, Manipulator Kinematics, Technical features, Programming, , end effecters, work cell design, internal external sensors, Group Technology, Flexible manufacturing systems , Material Handling System, Computer aided process planning (CAPP).

Lab: Mini project on CNC, Robotics, GT and FMS.

References:

1. M P Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Prentice Hall of India, 2008.
2. P Radhakrishnan, S Subramanyan, V Raju, *CAD/CAM/CIM*, (2e), New Age, International (P) Ltd, 2010.

AU3243: ARTIFICIAL INTELLIGENCE [2 0 2 3]

Significance of AI in automotive systems, Intelligent agents, Solving problems by searching, Informed search- Greedy Best First Search, AX Search, Hill Climbing, Uninformed search- Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search and comparisons, Adversarial search, Constraint Satisfaction Problems, Knowledge-based agents, Knowledge representation, Quantifying Uncertainty, Probabilistic reasoning, Fuzzy Sets and Fuzzy Logics, AI Techniques: Simulated Annealing, Tabu Search, Genetic Algorithm, Particle Swarm Optimization, Ant Colony Optimization, Artificial Neural Networks, Distributed AI and Multi Agent Systems. Overview of image processing and computer vision.Lab: Mini projects/Case studies on algorithm Applications.

References:

1. S Russell, P Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education, 2009.
2. M T Jones, *Artificial Intelligence: A Systems Approach*, Infinity Science Press LLC, 2008.

PROGRAM ELECTIVE- II

AU3244: COMPUTER AIDED DESIGN & FEA [2 0 2 3]

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations. Geometric Modelling: Types and representation of curves, Analytical curves, line, ellipse, parabola, Synthetic curves, Cubic, Bezier and B-spline curves, Types and representation of surfaces, Analytic surfaces, Plane, ruled, revolution and tabulated surfaces, Synthetic surfaces, cubic, Bezier and B-spline surfaces, Types and representation of solids, Solid representation, half spaces, Boundary Representation. Finite Element Analysis: Review of stress- strain relation and generalized Hooke's Law, Plane stress and Plain strain conditions, Concept of Total Potential Energy, Basic procedure for solving a problem using Finite Element Analysis. 1-D Analysis: Concept of Shape function and natural coordinates, strain-displacement matrix, derivation of stiffness matrix for structural problems, 1-D structural problems. Trusses: Formulation of stiffness matrix, simple truss problems to find displacement, reaction and stresses in truss members.

Lab: Structural analysis using Mechanical APDL.

References:

1. I K Zeid, *CAD/CAM Theory and Practice*, (2e), Tata McGraw Hill Publishing Company, 2012.
2. J Srinivas, *CAD/CAM Principles and Applications*, (1e) Oxford University Press, 2017.
3. J N Reddy, *An Introduction to Finite Element Method*, McGraw Hill Publication, 2003.
4. D Logan, *The Frist course in finite element method*, Cengage Learing, 2016.

AU3245: TWO AND THREE WHEELED VEHICLE SYSTEMS [2 0 2 3]

Classification, technical specification and layouts, Selection criteria of power plant, Starting Mechanism/ Procedure, scavenging, exhaust system layouts. Chassis & Sub Systems: Main frame and its types, Chain and shaft drive, Clutches, CVT, gear boxes - Types, purpose, construction and working principle - gear controls & shifting mechanism. Suspension & Steering Handle bar: Construction and working principle of Front and Rear suspension system. Steering mechanisms and Handle bar. Brakes and Wheels: Types, construction and working principle. Rims and Tires – Functions, materials, types, its advantages & comparison. Electrical Systems: Batteries, charging and ignition systems, Lighting and accessories. Instrumentation: Panel meters & controls, Switches, warning indicators / buzzers & actuating levers, Ignition key switch. Road Performance: Road holding & vehicle stability, seating and rider ergonomics, Various Safety measures & arrangements, Brake performance. Two & three wheeler Maintenance: Servicing, periodic check-ups. Trouble shooting, causes and remedies. Electric 2 & 3 wheelers.

Lab: Dismantling & assembling of a two and three wheeled engine, gear box, differential, and suspension system. Carburettors, injection system, Study of Kick starter mechanism Moped cranking mechanism, three wheeler drive line & chassis, wiring diagram & electrical systems, handle bar controls & adjustments, Rear & front brake overhauling & adjustments.

References:

1. D U Panchal, *Two and Three Wheeler Technology*, (2e), PHI Learning Private Limited, 2015.
2. K K Ramalingam, *Two Wheelers*, (2e), Scitech Publications Pvt. Ltd., 2014.
3. A De, *Vehicle Dynamics*, (1e), Galgotia Publications Pvt. Ltd., 2011.

AU3246: AUTOMOTIVE MATERIALS AND MANUFACTURING [2 0 2 3]

Automotive Materials: Overview of engineering materials and material selection criteria for automotive components, Car Body Materials, Materials for Engine Components, Materials for Chassis and Powertrain Components, Automobile Aluminum Sheet, Plastic Technology for Automotive Modules, High-Temperature Electronic Materials, Smart Materials. Automotive Manufacturing: Stamping and Metal Forming Processes. Automotive Joining: Welding- Robotic Fusion-Welding Operations, Adhesive Bonding. Automotive Painting: Immersion Coating Processes, Paint Curing Processes, Painting Spray Booths Operations, Painting Robotics. Final Assembly: Installation of the Trim Assembly and Chassis, Final Assembly and Testing Area, Ergonomics of the Final Assembly Area, Mechanical Fastening and Bolting. Additive manufacturing: 3D printing and materials. Composite manufacturing. Lab: Mini-projects based on selection of materials and manufacturing processes for automobile components.

References*:*

1. Omar, A Mohammed, *The automotive body manufacturing systems and processes*, John Wiley & Sons, 2011.
2. B Cantor, G Patrick, J Colin, *Automotive engineering: lightweight, functional, and novel materials*, CRC Press, 2008.
3. Jed Rowe, *Advanced materials in automotive engineering*, Elsevier, 2012.

AU3247: DATA ANALYTICS [2 0 2 3]

Probability Theory: Sample Spaces- Events - Axioms – Counting – Conditional Probability and Bayes' Theorem – The Binomial Theorem – Random variable and distributions: Mean and Variance of a Random Variable-Binomial-Poisson-Exponential and Normal distributions. Curve Fitting and Principles of Least Squares- Regression and correlation. Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Sampling distributions (Chi-Square, t, F, z). Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test - - Analysis of variance ANOVA – One way and two way classifications. Non-parametric tests: Chi-square test; Run test for randomness; One-sample and Two-sample sign tests; Mann-Whitney U-test for independent samples; Wilcoxon Signed-Rank test for paired samples; Kruskal-Wallis test. Design of experiment: definition, objective, strategies, factorial design, designing engineering experiments, ANOVA, EVOP, Fractional, Full and orthogonal Experiments, Taguchi methods for robust Design. Lab: Practice on Minitab: normality test, hypothesis testing for parametric and non-parametric items, correlation and regression analysis, DoE, factorial design.

References:

1. R A Johnson, I Miller, Freund, *Probability and Statistics for Engineers: Pearson New International Edition*, Pearson Higher Ed, 2013.
2. D C Montgomery, *Design and analysis of experiments*, John Wiley & Sons, 2017.
3. R I Levin, *Statistics for management*, Pearson Education India, 2011.
4. J Hair, R Anderson, B Black, B Babin, *Multivariate data analysis*, Pearson Education, 2016.

PROGRAM ELECTIVE- III

AU4140: PRODUCT DESIGN AND DEVELOPMENT [2 0 2 3]

Introduction: New product development, Characteristics, challenges, Economics, Value engineering, concurrent engineering, reverse engineering. Product development process: planning, concept development, system level design, detailed design, testing and refinement, production ramp up. Identifying Voice of Customer: Product opportunity identification, Perceptual mapping, Customer needs, Kano model, Quality function deployment, benchmarking, product specifications, conjoint analysis, Failure mode and effects analysis. Product Architecture: Integral and modular design, Robust design, Industrial design, Design for X – Manufacturing, Assembly, Environment, Six Sigma. Product Lifecycle Management: Concept, Elements and Significance, PLM Strategy, Information flow, PLM Database, life cycle assessment. Intellectual Property Rights: Patents, copyrights, trademarks, geographical indicators.Lab: Exercises based on idea generation, perceptual mapping, Kano analysis, QFD, conjoint analysis, life cycle assessment, value analysis, and SWOC.

References:

1. K T Ulrich, S D Eppinger, *Product Design and Development*, Tata McGraw Hill, Special Indian Edition, (5e), 2017.
2. A K Chitale, R C Gupta, *Product Design and Manufacturing*, (5e), PHI, 2011.
3. K Otto, K Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, (1e), Pearson Education, 2004.

AU4141: AUTOMOTIVE AIR CONDITIONING SYSTEMS [2 0 2 3]

Introduction to Air Conditioning : Components of Air conditioners, Operation of an Air-conditioning System, Type of Air conditioners, Heaters, Vehicle ventilation, combination heater and air conditioner, manually controlled air conditioner and heater system, automatically controlled air conditioner and heater systems, Air Heating equipment, Ducts, Registers and Grills, blowers, filters, Trouble Shooting and Services, Servicing of Air Conditioners. Psychrometry: Psychrometric properties and processes, sensible and latent heat loads, characterization and SHF load for ventilation and filtration, concepts of SHF and ESHF and ADP, concepts of human comfort and effective temperature. Automotive Refrigerants: Classification, properties and designation. Lab:- Tools used for Air conditioning overhauling, service, diagnosis and repair, Overhauling, routine service, diagnosis and repair of compressor, evaporator, condenser, receiver dryer expansion valve, accumulator and orifice, Testing of air conditioning system.

References:

1. B H Dwiggins, *Automotive Air Conditioning*, Cengage Learning, 2001.
2. C P Arora, *Refrigeration and Air Conditioning*, (3e), Tata Mc Graw Hill, 2017.
3. M. Prasad, *Refrigeration and Air Conditioning*, New Age International, 2002.
4. Q Zhang, S E Li, K Deng, *Automotive Air Conditioning: Optimization, Control and Diagnosis*, (1e), Springer, 2016.

AU4142: METROLOGY AND MEASUREMENT SYSTEM ANALYSIS (MSA) [2 0 2 3]

Introduction: measurement system- Units and standards, measuring instruments, sensitivity, readability, accuracy, precision, random errors-correction and calibration. Metrology and Inspection: linear and angular measurement- devices and systems, line and end standards. Limits, Fits and Tolerances: concept, Grades of Tolerances, Fits, Clearance, Interference and Transition. Gauges: Classification, construction, Taylor's Principle of Gauge Design and application, Interchangeability and selective assembly. Comparators: Types, Construction, Design and application. Optical measuring instruments: Principles of design, construction and operation. Measurement of Form Errors: Straightness, Flatness and Square measurement, Indicator method, Engineer's Square tester, Optical Square Screw Threads: Types, Principles of design and application. Surface Texture measurement: Methods, Principles of design and operation. Gear measurement: Gear terminology, Errors in gears, Composite tooth thickness, Gear tooth Vernier calipers, Constant chord method, Base tangent method, using precision rollers. Measurement System Analysis: Measuring instrument and tools calibration gauge study, attribute gauge study, gauge R&R, ANOVA gage R&R, factors affecting measurement systems.

Lab: Linear and angular measurement, Measurement of Form Errors, Measurement system analysis: measuring instrument and tools like calibrated gage study, attribute gage study, gage R&R, ANOVA gage R&R using Minitab software.

References:

1. E O Doebelin, D N Manik, *Doebelin's Measurement systems*, (6e), Tata McGraw-Hill, 2011.
2. A K Bewoor, V A Kulkarni, *Metrology & Measurement*, (16e), McGraw Hill Education, 2016.
3. A K Sawhney, M A Mahajan, *Textbook of measurement and metrology*, Dhanpat Rai & Co. 2014.

PROGRAM ELECTIVE- IV

AU4143: AUTOMOTIVE NOISE, VIBRATIONS & HARSHNESS [2 0 2 3]

Introduction to NVH: Noise, Vibration and Harshness (NVH) and its role in automotive design and development. Physiological effects of harshness due to noise and vibration, sources of vibration and noise in automobiles. Basics of Vibration Analysis: Basic concepts, mathematical models, formulating the equations of motion for linear and torsional system characteristics and response – damped and undamped single & two degree of freedom systems under harmonic force, coordinate coupling, generalized coordinates and modal analysis. Vibration Control Techniques: Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, Applications: isolation of the engine from vehicle structure and control of torsional oscillation amplitudes in engine crankshaft. Noise Fundamentals: Fundamentals of acoustics – general sound propagation – structure borne sound & air borne sound. NVH Measurements: Vibration and Noise Standards – Pass/Drive by noise, noise from stationary vehicles, interior noise in vehicles, NVH measurement tools and techniques. Automotive Noise Sources and Control Techniques: Methods for control of engine noise, Transmission Noise, Intake and Exhaust Noise, Aerodynamic Noise, Tyre Noise, Brake noise. Noise control strategy, noise control at source – along the path – isolation, damping, balancing, resonators, absorption, barriers and enclosure. Lab: Mini Projects on Noise isolation.

References:

1. R S Singirisu, *Mechanical Vibration*, Pearson Education, Delhi, 2004.
2. R V Dukkapatti, *Text Book of Mechanical Vibration*, Prentice Hall of India Ltd, 2004.
3. I J Daniel, *Engineering Vibration*, Prentice Hall, New Delhi, 2001.
4. G Shen, *Vehicle Noise, Vibration and Sound Quality*, SAE international, Warrendale, Pennsylvania, 2012.
5. M Harrison, *Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles*, Mathew Harrison Publication, 2004.

AU4144: EARTH MOVING EQUIPMENT [2 0 2 3]

Classification and requirements of off road vehicles: Land clearing machines, Earth moving machines Scrapers and graders, Shovels and ditcher's Power plants, chassis and transmission, multi axle vehicles. Transport equipment: Powered equipment, Tractors and Trollies, Trailers, Platform lift trucks, Fork lift trucks, containers and Supports. Hauling equipment: Type of dump trucks, On-road and Off- road way vehicles. Hoisting equipment: Jacks, truck mounted crane, Crawler crane, Outriggers. Tractors and tractors units: Tractors in earth moving Applications of tractors, Rating of Tractors, Wheeled and Crawler tractor, recent trends in tractor design, power shift transmission and final drive in caterpillar tractor. Motor grader: recent trends, control mechanism of a caterpillar motor grader. Earth moving machines: Bulldozers, cable and hydraulic dozers. Crawler track, running and steering gears, scrapers, drag and self-Powered types - dump trucks and dumpers - loaders, single bucket, multi bucket and rotary types - power and Capacity of earth moving machines. Lab: Hydraulic trainer explains the hydraulic principle used in crawler

tractor, power shift transmission and final drive. Pneumatic trainer explains the circuit used in pneumatic brake system used in heavy vehicle.

References:

1. V Mahesh, *Construction Equipment and its Planning and Applications*, Metropolitan Books Co., Delhi, 2004.
2. H Nichols, D Day, *Moving the Earth: The Workbook of Excavation*, (6e), McGraw-Hill Education, 2010.
3. S C Jain, C R Rai, *Farm Tractor: Maintenance and Repair*, Standard Publishes-Distributors, 2012.
4. D N Sharma, S Mukesh, *Design of Agriculture Tractor*, (4e), Jain Brothers, 2012.
5. H Taghavifar, A Mardani, *Off-road Vehicle Dynamics*, (1e), Springer International Publishing, 2017.

AU4145: OPTIMIZATION TECHNIQUES [2 0 2 3]

Introduction to optimization; Linear Programming: Statement of LP problem, graphical method, Simplex method, Degeneracy, Duality, Post Optimal and Sensitivity Analysis. Allocation problems: Transportation model, Assignment model, Trans-shipment; Waiting Line Models: Classification, States in queue, Probability distribution of arrivals and service times, Single server model (M/M/l), Multiple server model (M/M/S), Single server model with finite capacity; Game Theory: Rectangular, Two persons Zero sum games, Maximin and Minimax Principles, Saddle point, Dominance, Graphical and Algebraic methods, Solution by transforming into LPP. Integer Programming: cutting plane method, branch and bound method; Introduction to Goal Programming, Dynamic Programming, and Simulation. Lab: Exercises using Tora software.

References:

1. S S Rao, *Engineering Optimization: Theory and Practice*, (3e), New Age International Publishers, 2013.
2. H A Taha, *Operations Research; An Introduction*, (9e), Pearson Publication, 2014.
3. W L Winston, *Operations Research: Applications and Algorithms*, (4e) Thomson Learning, 2004.
4. J C Pant, *Introduction to Optimization techniques*, (7e), Jain Brothers, 2008.

PROGRAM ELECTIVE- V

AU4146: VEHICLE ERGONOMICS AND SAFETY SYSTEMS [2 0 2 3]

Introduction, Anthropometry and Biomechanics in vehicle design, Occupant packaging- seating layout, key dimensions, Reference points, Ingress & egress, Driver Information Acquisition and Processing, positioning of Controls & Displays, Field of View, Automotive Lighting - headlight, signals, dazzling & preventive methods. Crashworthiness- crumble zones & vehicle structure, regulations & tests, Seat Belts, Air Bags, Active safety technologies- Collision detection and avoidance, Detection of Lane departure warning, blind spot & object detection, Antilock Brakes (ABS), Electronic Stability (ESP). Lab: Exercises and mini projects using Technomatix and Excel software.

References:

1. V D Bhise, *Ergonomics in the Automotive Design Process*, CRC Press, 2012.
2. P D Bois, *Vehicle Crashworthiness and Occupant Protection*, American Iron and Steel Institute, 2004.
3. K Reif, *BOSCH Automotive Mechatronics*, Springer Vieweg, 2015.
4. R Jurgen, *Automotive Electronics Handbook*, McGraw Hill, 2000.

AU4147: AUTOTRONICS AND AUTONOMOUS VEHICLES [2 0 2 3]

Application of electronics in Automobiles: Architecture of vehicle electronic systems, Motronic engine-management systems, ECUs, Automotive networking, BUS systems, Sensors- types, measuring principle, Actuators. Electronic Transmission control, Anti-lock braking system (ABS), Traction Control system (TCS), Electronic Stability Program (ESP), Electronic Diesel Control (EDC), Vehicle Security Systems, On-Board Diagnosis systems. Components of Autonomy in cars, control in autonomous system, system architecture, sensors, estimation, Localization and Mapping, navigation and path planning, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communications and Cooperative Driving, Traffic Control and Traffic Management in a Transportation System with Autonomous Vehicles, Risk Based Navigation Decisions, Intelligent Vehicle Potential and Benefits.
Lab: Exercises and mini projects using MATLAB.

References:

1. K Reif, *Automotive Mechatronics (BOSCH)*, Springer Vieweg, 2015.
2. R BOSCH Gmbh. *Automotive Electrics and Automotive Electronics (BOSCH)*, (5e), Springer Vieweg, 2007.
3. L Vlacic, M Parent, *Intelligent Vehicle Technologies*, (1e), Butterworth-Heinemann, 2001.
4. U Ozguner, T Acarman, K Redmill, *Autonomous Ground Vehicles*, (1e), Artec House, 2011.

AU4148: PRODUCTION AND OPERATIONS MANAGEMENT [2 0 2 3]

Forecasting: Need for forecasting, Quantitative methods. Capacity and aggregate planning: Capacity measurement, Long-term and short term strategies, Aggregate planning. Inventory management: Various costs in inventory management and need, Deterministic models and discounts, Probabilistic inventory management. Scheduling: Models and applications, Scheduling in MRP system, Sequencing rules and applications, Batch production sequencing and scheduling, line balancing models. Facility layout and location: Qualitative aspects, Quantitative models for layout decisions. Product, process fixed position, group layout. Location decisions-quantitative models. Project Management: Project Management principles, utilizing work breakdown structures (WBS) to identify project schedule, different types of project management methods, scheduling using Gantt Charts, PERT/CPM. Lab: Mini-projects and case studies.

References:

1. R B Chase, N J Aquilano, F R Jacobs, *Operation Management for Competitive Advantage*, (9e), Tata McGraw-Hill, Delhi, 2002.
2. D A Collier, J R Evans, *Operations Management*, Cengage Learning, 2016.
3. J Heizer, B Render, *Operations Management*, Pearson, 2013.
4. R R Venkataraman, J K Pinto, *Operations Management: Managing Global Supply Chains*, Sage Publisher, 2017.

PROGRAM ELECTIVE-VI

AU4149: COMPUTATIONAL FLUID DYNAMICS [2 0 2 3]

Introduction to CFD, Objectives, philosophy of CFD, application of CFD in automobile engineering. Conservation laws of Fluid Dynamics, continuity, momentum and energy equations, Classification and Mathematical behavior of PDEs, Conservative and Non-conservative forms, Structured and Staggered grid, Implementation of boundary conditions. Discretization Process - concept and structure, Finite Volume methods. Diffusion and Convection-Diffusion Problems, Upwind, Hybrid and QUICK schemes. Solution algorithms: SIMPLE, SIMPLEC, TDMA, Point Iterative Methods, Explicit methods - Crank Nicolson, Implicit methods. Errors and Uncertainty in CFD.Lab: Mini Projects based on ANSYS - Fluent.

References:

1. S V Patankar, *Numerical Heat Transfer and Fluid Flow*, (1e), Hemisphere- McGraw Hill,Reprint- 2017.
2. H K Versteeg, W Malalasekera, *An Introduction to Computational Fluid Dynamics*, Pearson, 2008.
3. K.Muralidhar, T.Sundararajan, *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, 2009.

AU4150: AUTOMOTIVE SERVICE OPERATIONS [2 0 2 3]

Service office Management: Service Parameters- Customer engagement index, technician skill enhancement, Function and role of service advisor and area technical lead. Warranty Processing system, Spare Parts Management at dealership, Customer Care management at service center.

Lab: Case study about enhancement customer satisfaction index (CSI) through improve service operation.

References:

1. A Chikara*, Automobile Marketing & workshop techniques: Automobile Engineering Vol-3*, Satya publication, 2016.
2. A Rezin, *Automotive Service Management- Principle to service*, PHI publication, 2018.
3. C E Oven, *Basic Automotive Service and System*, Delmar Cengage Learning, 2015.
4. A A Rezin, *Automotive Service Management Principles into Practice*, (3e), Pearson, 2013.
5. J A Doshi , *Vehicle Maintenance and Garage Practice*, PHI Publication, 2017.

AU4151: STASTISTICAL PROCESS CONTROL AND STASTICAL QUALITY CONTROL [2 0 2 3]

Introduction: Statistical Methods for Quality Control and Improvement; Methods and Philosophy of Statistical Process Control: Variation, cause of variation, Types of Variation. Control Charts: Basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, sensitizing rules for control charts. Control Charts for Variables: Control Charts for X bar and R, X bar and S, Individual Measurements - development and use, estimating process capability, interpretation and average run length, Applications of Variables Control Charts. Control Charts for Attributes*:* Control Chart for Fraction - p, np c and u chart, Implementing SPC: An Application of SPC, Nonmanufacturing application of SPC. ImR and X-bar & R-charts, Guideline for Implementing Control charts. Acceptance Sampling: OC curve, the OC function and ARL calculation; Lot-By-Lot Acceptance Sampling For Attributes: Concept of sampling inspection and acceptance

Sampling, Comparison with 100% Inspection, Cost of inspection, sampling by attributes – Single, Double and Multiple sampling plans, Operating characteristic curve, AOQ curve, AOQL, Producer's and Consumer's risks,, Dodge-Romig and MIL-STD acceptance sampling tables. Process Capability Analysis: Analysis using a histogram or a probability plot, process capability ratios, Cpk, Cp, Ppk, Pp, confidence interval for process-capability ratio, PCA using a control chart, estimating natural tolerance limits of a process. Lab: Mini projects using Minitab.

References:

1. E L Grant, R Leavenworth, *Statistical Quality Control*, (7e), McGraw Hill Education, 2017.
2. D C Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley and Sons, New York, 2009.
3. A Mitra, *Fundamentals of Quality Control and Improvement*, (3e), Wiley India, 2013.

AU 14152: MACHINE LEARNING [2 0 2 3]

Introduction to Machine Learning. Python for Machine Learning, Supervised vs Unsupervised, Regression, Simple Linear, Non Linear, Multiple Linear Regression, Model Evaluation, Evaluation Metrics. Classifications, K-Nearest Neighbours, Decision Trees, Building Decision Trees, Logistic regression vs Linear regression, Support Vector Machine, Clustering, k-Means, Hierarchical Clustering, DBSCAN, Recommender Systems, Content-based Recommender Systems, Collaborative Filtering, Lab: Minor Projects based on Python programming.

References:

1. A C Muller, S Guido, *Introduction to Machine Learning with Python*, (1e), O'Reilly, 2016.
2. E Alpaydin, *Introduction to Machine Learning*, (2e), MIT Press, 2010.
3. M Kubat, *An Introduction to Machine Learning*, (1e), Springer, 2015.

PROGRAM ELECTIVE-VII

AU4153: ALTERNATIVE FUELS AND ENERGY SYSTEMS [2 0 2 3]

Need for alternative fuels. World and Indian energy scenario on alternative fuels. Availability of different alternative fuels for SI and CI engines. Alcohols: Production methods, Properties, Methods of using alcohols in CI and SI engines. Performance emission and combustion characteristics. Vegetable oils: Various vegetable oils and their important properties, methods of using vegetable oils engines – Blending, preheating Transesterification and emulsification of Vegetable oils, Performance, Emission and Combustion Characteristics in diesel engines. Role of Nano fluids, additives and cetane improvers for performance improvement of vegetable oils as fuel. Hydrogen: Production methods, Combustive properties, Problems associated with hydrogen, Different methods of using hydrogen in SI and CI engines, Performance, emission and combustion analysis in engines. Biogas, LPG and Natural gas: Production methods, Properties, CO2 and H2S scrubbing in Biogas., Modification required to use in SI and CI Engines-Performance and emission characteristics SI and CI engines. Energy Systems: Introduction to Solar Energy conversion, solar cells, fuel cells and super capacitors & their role in automobiles. Lab: Combustion Analysis experiments on SI & CI engine by varying CR, Injection Timing, and Injection Pressure using in-house made bio-diesels.

References:

1. S S Thipse, *Alternative Fuels*, (India Edition), Jaico Publications, 2013.
2. M A Gajendra Babu, K A Subramanian, *Alternative Transportation Fuels*, CRC Press, 2013.

AU4154: AUTOMOTIVE POLLUTION AND CONTROL [2 0 2 3]

Introduction: Pollutants – sources, formation, effects of pollution on environment& human, transient operational effects on pollution, Regulated &Unregulated emissions - Emission Standards - Introduction to BS-VI. Emissions in SI Engine: Chemistry of SI engine combustion, HC and CO formation in SI engines, NO formation in SI engines, Smoke emissions from SI engines, Effect of operating variables on emission formation. Emissions in CI Engine: Smoke emission and its types, NOx emission and its types, Particulate, Odor, sulfur and Aldehyde emissions, effect of operating variables on emission formation. Control Techniques for Reduction of Emission: Design modifications, Optimization of operating factors, Fuel modification , Evaporative emission control, Exhaust gas recirculation, DOC, SCR, Fumigation, Secondary Air injection, PCV system, Particulate Trap, CCS, Exhaust treatment in SI engines, Thermal reactors, Catalytic converters, Catalysts, Noise reduction devices. Test Procedure, Instrumentation & Emission Measurement: Test procedures CVS1, CVS3, Test cycles – IDC, ECE, FTP, NDIR analyser, Flame ionization detectors, Chemiluminescent analyzer – Dilution tunnel - Gas chromatograph – Smoke meters –SHED test. Lab: Smoke & 5 gas emission tests from SI & CI engine under different CR, Injection timing, Injection Pressure, varous blends of fuels and blends of bio-diesel.

References:

1. B P Pundir, *IC Engine Combustions and Emissions*, Narosa Publications, 2018.
2. B P Pundir, *Engine Emissions*, Narosa Publications, 2018.
3. P S Myers, *Engine Emissions: Pollutant Formation and Measurement*, Springer US, 2009.

AU4155: VEHICLE FAULT DIAGNOSIS AND TROUBLESHOOTING [2 0 2 3]

Different diagnosis approaches, Type and identification of faults, Tools and garage equipment used in fault diagnosis, overhauling and maintenance, Fault diagnosis techniques for automotive subsystems, diagnostic codes. Troubleshooting: identification and troubleshooting of engine, other sub systems and vehicle body, Safety measures during vehicle troubleshooting. Automotive maintenance practices.

Lab: Garage layouts, Fault diagnosis and troubleshooting practices for automotive systems.

References:

1. W H Crouse, *Automotive mechanics*, (10e), McGraw Hill Education, 2017.
2. T Denton, *Automotive Fault Diagnosis*, (4e), Routledge, 2016.
3. A Chikara, *Vol-1 Automotive Marketing and workshop Practice*, Staya Publication, 2012.
4. R K Rajput, *Automobile Engineering*, (5e), Laxmi Publication, 2015.
5. R B Gupta, *Automobile Engineering*, (4e), Satya Publication, 2015.

AU4156: AUTOMATIC CONTROL SYSTEM [2 0 2 3]

Introduction to Control Theory, Mathematical Models of Electrical: mechanical and electro-mechanical systems, block diagram - signal flow graphs, Mason's gain formula, Time Response: transient response specifications of second order systems, system response with additional pole & zero, Steady state error non- unity feedback systems, Sensitivity Stability: Routh - Hurwitz criterion, frequency domain specifications, Automotive Control System design process, Powertrain Control systems for air-fuel ratio, spark timing, idle-speed, transmission control, Vehicle Control System for cruise and headway, vehicle stability, active suspension, ABS, Traction control, Intelligent transportation systems, advanced vehicle control system, longitudinal and Lateral motion control. Lab: Introduction of PLC, Automatic opening and closing door, Verify the Operation of Different Logic Gates, Direct online Starter.

References:

1. A G Ulsoy, H Peng, M Cakmakci, *Automotive Control Systems*, (1e), Cambridge University Press, 2012.
2. U Kiencke, L Nielsen, *Automotive Control Systems*, (2e), Springer, 2005.
3. R Bishop, *Intelligent Vehicle Technology and Trends*, (1e), Artec House, 2005.
4. F D Petruzella, *Programmable Logic Controllers*, McGraw Hill Education, 2010.

OPEN ELECTIVES

AU2080: FUNDAMENTALS OF AUTOMOBILE ENGINEERING [3 0 0 3]

Evolution of Automobile engineering, Automotive engines, different types of chassis and frame, ignition system, lubrication system, carburettor and injection system. Steering systems and axles: Steering systems, Front Axles, Rear axles, Brake Introduction, classification, construction, function, operation of mechanical, hydraulic, disc, drum, Power brakes, Air brakes, vacuum brakes. Transmission System: clutch, Gear box and differential, Suspension: construction, operation and spring materials, leaf springs, coil springs, torsion bar, rubber springs, air bellows, pneumatic suspension, hydraulic suspension, Wheels and Tyres. Basic wiring diagram of vehicle electrical system, Vehicle air conditioning: Introduction, construction and working of compressor, condenser, evaporator and expansion devices.

References:

1. S K Gupta, *A text book of automobile engineering*, S. Chand, 2014.
2. K Singh, *Automobile engineering- (Vol.1)*, Standard Publication Distributor, 2012.
3. R B Gupta, *Automobile engineering*, Satya Prakashan, 2012.
4. N K Giri, *Automotive Mechanics*, Khanna Publications, 2003.

AU2081 FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLE [3 0 0 3]

Fundamentals of Vehicle Propulsion, vehicle resistances, powertrain characteristics, vehicle performance, braking, tires. Batteries- Types, Parameters, Capacity, Charge / Discharge rate, SOC, DOD, Battery pack Design, Safety issues and hazards.

Overview of Electric vehicles - Hybrid Electric vehicles architectures, Types – series, parallel, mild, complex configurations, Plug in hybrid electric vehicle – Design – Drive train, sizing of components. Vehicle simulation (simulation model, standard drive cycles). Electric Machine fundamentals (motional voltage, EMF), simple DC machines (induced voltage, force and torque, DC machine back emf and torque, simple reluctance motor). DC machines, Three phase AC machines. Induction machines. Permanent magnet machines. Switched reluctance machines. Power electronic switches. DC/DC converters. case studies on EVs and HEVs, Components of DC and AC Charging System for vehicle, Fast Charging, Ultra-Fast charging systems

References:

1. J D Haldeman, *Hybrid and Alternative Fuel Vehicles*, (2e), Pearson. Education, 2012.
2. I Hussain, *Electric and Hybrid Vehicles: Design Fundamentals*, (2e), CRC Press, 2010.
3. A E Fuhs, *Hybrid Vehicles and the Future of Personal Transportation*, CRC Press, 2009.
4. J German, *Hybrid powered Vehicles*, (2e), SAE International, 2011.
5. M Ehsani, Y Gao, A Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals*, Theory, and Press, 2009.

AU2082: LEAN SIX SIGMA PROBLEM SOLVING [3 0 0 3]

Introduction to Six Sigma, Lean, Lean Six Sigma and DMAIC (Define, Measure, Analysis, Improve & Control); Linking Lean Six Sigma to Strategy and Project Selection as it pertains to the Internship program, Understand the Lean Six Sigma Roadmap – Define, Measure, Improve, Control; Actions required for completing the Define Phase – Project Definition, Prioritize projects based on value, resources required, timing, Select projects with buy in from Industry sponsoring internship. Establish accountability between business and student intern. Develop and present project charter. Utilize 8 Disciplines (8D) problem solving team based methodology for a live problem and report out using industry standard methods.

References:

1. M L George, J Maxey, D T Rowlands, M Upton*, Lean Six Sigma*, McGraw-Hill Education India, 2004.
2. S Shaffie, S Shahbazi, *The McGraw-Hill 36-Hour Course: Lean Six Sigma*, McGraw-Hill 2012.

AU2083: TRENDS IN VEHICLE STYLING AND ERGONOMICS [3 0 0 3]

Introduction to styling Car Design, Fundamentals of perspective drawing, Automotive Sketching, Styling process, Car proportions, Aerodynamics, Crashworthiness and its influence on body design, Designing of Interiors Form studies Form studies, Speed Forms, Clay Modeling, 2D systems, 3D systems Fundamentals of Ergonomics Dimension Determination, Anthropometry – Need, Data collection methodology, Different postural considerations, Measuring Procedures Subject and Sampling size selection, Measurement of Hands/Feet/Full posture, Applying Anthropometry data, Application of percentile curves Vehicle Ergonomics Passenger Compartment, Floor Pan, Technical requirements, Dash board equipments arrangement, Positioning of operational controls, Force Analysis, Seating and position(ECE Regulations),Human Factors, Navigation systems, pedal positioning Vehicle Packaging R-Point, AHP, Manikin positioning of 2-D pattern, car entry/exit, Sight – All round visibility, View of Instruments, Mirror design, Logical formation of cockpit, Boot lid packaging, Loading/Unloading analysis.

References:

1. V D Bhise, *Ergonomics in the Automotive Design Process*, CRC Press, 2012.
2. P D Bois, *Vehicle Crashworthiness and Occupant Protection*, American Iron and Steel Institute, 2004.
3. K Reif, *BOSCH Automotive Mechatronics*, Springer Vieweg, 2015.

AU3080: ENGINE EMISSIONS AND CONTROL [3 0 0 3]

Introduction: Pollutants – sources, formation, effects of pollution on environment& human, transient operational effects on pollution, Regulated &Unregulated emissions - Emission Standards - Introduction to BS-VI. Emissions in SI Engine: Chemistry of SI engine combustion, HC and CO formation in SI engines, NO formation in SI engines, Smoke emissions from SI engines, Effect of operating variables on emission formation. Emissions in CI Engine: Smoke emission and its types, NOx emission and its types, Particulate, Odor, sulfur and Aldehyde emissions, effect of operating variables on emission formation. Control Techniques for Reduction of Emission: Design modifications, Optimization of operating factors, Fuel modification , Evaporative emission control, Exhaust gas recirculation, DOC, SCR, Fumigation, Secondary Air injection, PCV system, Particulate Trap, CCS, Exhaust treatment in SI engines, Thermal reactors, Catalytic converters, Catalysts.

References:

1. B P Pundir, *IC Engine Combustions and Emissions*, Narosa Publications, 2018.
2. B P Pundir, *Engine Emissions*, Narosa Publications, 2018.
3. P S Myers, *Engine Emissions: Pollutant Formation and Measurement*, Springer US, 2009.

AU3081: AUTOMOTIVE MATERIALS AND MANUFACTURING PROCESSES [2 0 2 3]

Automotive Materials: Overview of engineering materials and material selection criteria for automotive components, Car Body Materials, Materials for Engine Components, Materials for Chassis and Powertrain Components, Automobile Aluminum Sheet, Plastic Technology for Automotive Modules, High-Temperature Electronic Materials, Smart Materials. Automotive Manufacturing: Stamping and Metal Forming Processes, Automotive Joining: Welding- Robotic Fusion-Welding Operations, Adhesive Bonding. Automotive Painting: Immersion Coating Processes, Paint Curing Processes, Painting Spray Booths Operations, Painting Robotics. Final Assembly: Installation of the Trim Assembly and Chassis, Final Assembly and Testing Area, Ergonomics of the Final Assembly Area, Mechanical Fastening and Bolting. Additive manufacturing: 3D printing and materials. Composite manufacturing.

References:

1. Omar, A Mohammed, *The automotive body manufacturing systems and processes*, John Wiley & Sons, 2011.
2. B Cantor, G Patrick, J Colin, A*utomotive engineering: lightweight, functional, and novel materials*, CRC Press, 2008.
3. Jed Rowe, *Advanced materials in automotive engineering*, Elsevier, 2012.

AU3082: AUTOTRONICS [3 0 0 3]

Application of electronics in Automobiles: Architecture of vehicle electronic systems, Motronic engine-management systems, Electronic Control Units, Automotive networking, BUS systems, Automotive Sensors- types, measuring principle, Electric Actuators, Electronic Transmission control, Anti-lock braking system (ABS), Traction Control system (TCS), Electronic Stability Program (ESP), Electronic Diesel Control (EDC), Sensotronic Brake Control, Vehicle Security Systems, On-Board Diagnosis systems.

References:

1. K Reif, *Automotive Mechatronics (BOSCH)*, Springer Vieweg, 2015.
2. R BOSCH Gmbh. *Automotive Electrics and Automotive Electronics (BOSCH)*, (5e), Springer Vieweg, 2007.
3. L Vlacic, M Parent, *Intelligent Vehicle Technologies*, (1e), Butterworth-Heinemann, 2001.

AU3083: PROCESS CONTROL AND RELIABILITY ENGINEERING [3 0 0 3]

Introduction to Quality: Definition of quality control, quality assurance, quality audit, dimensions of quality, seven quality tools, type of quality costs, cost of poor quality (COPQ) calculation methodology. Quality Control: concept of variation, causes of variation, types of variation, control charts for variables: X-bar chart and R chart, control chart for attributes: p-chart and c-chart, process capability indices, performance capability indices. Acceptance Sampling: Introduction, Single and double sampling plan, operating characteristic curve, AOQ curve, AOQL, Average Total Inspection, Average Fraction Inspected, ASN curve, Producer's and Consumer's risks. Reliability: Concepts of reliability, Quality and Reliability, Failure Rate, Failure Density, Life testing, MTBF, MTTF, Maintainability & Availability, Hazard functions, Reliability Allocation - Series Systems, Parallel Systems, Combined Series and parallel Systems.

References:

1. A Mitra, *Fundamentals of Quality Control and Improvement*, (3e), Wiley India, 2013.
2. E L Grant, R Leavenworth, *Statistical Quality Control*, (7e), McGraw Hill Education, 2017.
3. D C Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley and Sons, New York, 2009.
4. C E Ebeling, *An Introduction to Reliability and Maintainability Engineering*, (8e), Tata McGraw-Hill, 2007.

AU3084: VEHICLE MAINTENANCE AND GARAGE PRACTICE [3 0 0 3]

Maintenance Objectives, classification, preventive, running and breakdown maintenance, maintenance schedules, workshop manuals, owner's manual, Warranty Procedures, Pre-delivery inspection (PDI): front manager, service advisor: functions and duties. Condition Based Maintenance (CBM): Benefits, Objectives, Principles, Techniques, manual inspections. Vehicle Maintenance Tools and Equipment's: denting tools, painting, testing and Service equipment. Maintenance: schedule for engine and drive line, Cooling and lubrication system, braking, suspension and steering systems. Engine Overhauling: Procedure for engine removal from vehicle; disassembly; cleaning procedures; agents; Decarburizing; Top overhauling; Visual inspection; inspection by measurement. Wheels and Tyres: wheel balancing and alignment, tyre specifications and maintenance.

References:

1. J Doshi, *Vehicle Maintenance and Garage Practice*, (4e), EEE, 2017.
2. R K Rajput, *Automobile Engineering*, (6e), Laxmi Publication, 2012.
3. N K Giri, *Automotive Mechanics*, Khanna Publication, 2015.

4. A Chikara, *Vol-3- Automotive marketing and workshop practice*, Satya Publications, 2018.

AU3085: AUTOMOTIVE SAFETY SYSTEMS [3003]

Automotive safety– Introduction and Types. Passive safety concepts: Design of body for safety, deceleration of vehicle and passenger, crumple zone, safety cage. Optimum crash pulse, deceleration on impact with stationary and movable obstacles, deformation behaviour of vehicle body and lightweight materials. Passive safety equipment and convenience system: Seat belt system, collapsible steering column, Air bags, automotive bumpers, steering and mirror adjustment, central locking system, Tire pressure monitoring system, rain sensor system, automated wiper system. Active safety: Antilock braking system, Stability Control, Adaptive cruise control, Lane Keep Assist System, Collision warning, avoidance system, Blind Spot Detection system, Driver alertness detection system.

References:

1. R Jurgen*, Automotive Electronics Handbook*, McGraw Hill, 2000.
2. G Peters, B Peters, *Automotive Vehicle Safety*, CRC Press, 2014.
3. S Ulrich, *Automotive Safety handbook*, SAE International, 2013.

AU3086: TOTAL QUALITY MANAGEMENT [3 0 0 3]

Meaning of Quality, Customer Satisfaction and TQM, Philosophies of Quality - Deming, Juran And Crosby, Scope and Principles of TQM, Cost of Quality and its Relevance to TQM; TQM for Middle Management: Process Management, Statistical Process Control (SPC)- control charts for variables and attributes, process capability, acceptance sampling; TQM for Workforce: Kaizen teams, Quality Circles; TQM for Leadership: Strategic Quality Management, Competitive Advantage; Tools used in TQM - Seven tools, QFD, FMEA; Quality Auditing, ISO 9000 and 14000 Standards.

References:

1. F Gryna, R Chua, *Juran's Quality Planning and Analysis for Enterprise Quality*, McGraw Hill Education, 2017.
2. J M Juran, J A DeFeo, *Juran's Quality Handbook*, McGraw Hill Education, 2017.
3. E L Grant, R S Leavenworth, *Statistical Quality Control*, McGraw Hill Education, 2017.
4. H Gitlow, R Oppenheim, A Oppenheim, D Levine, *Quality Management*, McGraw Hill Education, 2017.

AU3087 PRODUCT DEVELOPMENT [3 0 0 3]

New product development: Introduction, characteristics and challenges, concurrent engineering, reverse engineering. Product development process: planning, concept development, system level design, detailed design, testing and refinement, production ramp up. Identifying Voice of Customer: Product opportunity identification, Perceptual mapping, Customer needs, Kano model, Quality function deployment, product specifications, failure mode and effects analysis. Product Architecture: Integral and modular design, Robust design, Industrial design, Design for X – Manufacturing, Assembly, Environment, Six Sigma. Product Lifecycle Management: Concept, Elements, Significance and Strategy, Life cycle assessment. Intellectual Property Rights: Patents, copyrights, trademarks, geographical indicators.

References:

1. K T Ulrich, S D Eppinger, *Product Design and Development*, Tata McGraw Hill, Special Indian Edition, (5e), 2017.
2. A K Chitale, R C Gupta, *Product Design and Manufacturing*, (5e), PHI, 2011.
3. K Otto, K Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, (1e), Pearson Education, 2004.

Department of Chemical Engineering

The Department of Chemical Engineering at Manipal University Jaipur was established in 2014. The department has talented, young, dynamic and enthusiastic faculty members from India and abroad. The department runs undergraduate (UG) and doctoral programs. The well-equipped laboratories with standard and modern equipment (including softwares) enable the students to develop strong fundamental principles to troubleshoot everyday industrial problems. Advanced teaching methodology and industrial experience of the faculty help bridge the gap between classroom teaching and industry.

The department conducts industrial visits, symposiums and workshops on emerging and important topics every year for the undergraduate students enabling them to relate their theoretical knowledge to industrial applications. Student Chapter of the professional body, Indian Institute of Chemical Engineers (IIChE), is an excellent front for students to connect and organize events that cater to their professional development. The department also has to its credit the memorandum of understanding (MoU) with various eminent institutes and industries such as Indian Institute of Petroleum, Dehradun (IIP Dehradun); Curtin University Malaysia; and EcoSense Ltd., Aurangabad for research and training purposes. The faculties of the department are involved in high-end research in a majority of the areas cited as problems by the 2015 UN report, which include Water, Energy, Climate Change, Health, Materials and so on. The students are continuously motivated to participate in national and international conferences and other events within the country to excel in both curricular and co-curricular activities.




B.Tech in Chemical Engineering
(Course Structure & Syllabus III Semester Onwards)

YEAR	THIRD SEMESTER						FOURTH SEMESTER					
	Course code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value Ethics and Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA2105	Engineering Mathematics-III	2	1	0	3	MA2208	Engineering Mathematics-IV	2	1	0	3
	CE2101	Chemical Process Calculations	3	1	0	4	CE2201	Chemical Reaction Engineering-I	3	1	0	4
	CE2102	Momentum Transfer Operations	3	1	0	4	CE2202	Heat Transfer Operations	3	1	0	4
	CE2103	Chemical Engineering Thermodynamics	3	1	0	4	CE2203	Mass Transfer-I	3	1	0	4
	CE2104	Transport Phenomena	3	1	0	4	XXXXXX	Open Elective-I	3	0	0	3
	CE2130	Transport Phenomena Lab-I	0	0	4	2	CE2230	Transport Phenomena Lab-II	0	0	4	2
							CE2231	Process Equipment Design Lab	0	0	3	1
			16	5	4	23			17	4	7	24
	Total Contact Hours (L+T+P)		25				Total Contact Hours (L+T+P)+OE		28			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	BB0026	Organisation and Management	3	0	0	3	CE3201	Process Plant Design	3	1	0	4
	CE3101	Mass Transfer-II	3	1	0	4	CE3202	Chemical Process Industries	3	1	0	4
	CE3102	Chemical Reaction Engineering-II	3	1	0	4	CE3203	Process Dynamics and Control	3	1	0	4
	CE3103	Process Modeling and Simulation	3	0	2	4	CE32XX	Program Elective-I	3	0	0	3
	CE3104	Process Safety Analysis	3	1	0	4	CE32XX	Program Elective-II	3	0	0	3
	XXXXXX	Open Elective -II	3	0	0	3	XXXXXX	Open Elective-III	3	0	0	3
	CE3130	Transport Phenomena Lab- III	0	0	4	2	CE3230	Chemical Reaction Engineering Lab	0	0	4	2
							CE3231	Process Dynamics and Control Lab	0	0	3	1
			18	3	6	24			18	3	7	24
	Total Contact Hours (L+T+P) + OE		27				Total Contact Hours (L+T+P)+OE		28			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	CE41XX	Program Elective-III	3	0	0	3	CE4270	Major Project	0	0	0	12
	CE41XX	Program Elective-IV	3	0	0	3						
	CE41XX	Program Elective -V	3	0	0	3						
	CE41XX	Program Elective-VI	3	0	0	3						
	CE41XX	Program Elective-VII	3	0	0	3						
	CE4170	Minor Project	0	0	4	2						
	CE4171	Industrial Training	0	0	2	1						
			15	0	6	18						12
	Total Contact Hours (L+T+P)		21				Total Credit= 169(including first year)					

THIRD SEMESTER

BB0025: VALUE ETHICS AND GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications.

MA2105: ENGINEERING MATHEMATICS III [2 1 0 3]

Periodic Functions, odd and even functions, Euler's formulae. Half range expansions, Harmonic analysis. Fourier integrals & transforms, Parseval's identity. Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Conformal mappings, bilinear transformations. Gradient, divergence and curl, their physical meaning and vector identities. Line, surface and volume integrals. Green's theorem, divergence and Stokes' theorem, applications. Formation, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of Variables. Derivation of one dimensional wave equation (vibrating string) and its solution by using the method of separation of Variables. D'Alembert's solution of wave equation. Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables.

References:

1. Eewin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc.1993.
2. R. Spiegel Murray, *Vector Analysis*, 2(e), Schaum Publishing Co., 2009.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
4. B.V. Ramana, *Engineering Mathematics*, 2(e), Tata McGraw Hill Publishing Company limited, 2007.

CE2101: CHEMICAL PROCESS CALCULATIONS [3 1 0 4]

Guidelines for Problem Solving; Review of Basic concepts – Process variables & properties, Degree of Freedom, Material balances: Steady State Material Balances – in non-reacting systems and reacting system, Recycle & purge, elemental vs. species balance, combustion of fossil fuels. Multiphase equilibrium: Single component and multicomponent phase equilibrium, Steady State Material balances in Multiphase systems. Energy Balances: Steady State Energy Balances – in non-reacting & reacting systems, De-Coupled & coupled mass & energy balances, Calculations for network of units with recycle & bypass, Process Flow sheeting with sequential modular calculations, Unsteady State Balances. Humidification: Terminology of humidity, Humidity charts, heating and cooling problems of moist air.

References:

1. D.M. Himmelblau, J.B. Riggs, Basic Principles and Calculations in Chemical Engineering, (8e) Pearson, TN, 2015.
2. R.M. Felder, R.W. Rousseau, Elementary Principles of Chemical processes, (3e), Wiley, 2004.
3. B.I. Bhatt, S.B. Thakore, Stoichiometry, (5e), McGraw Hill, 2010.

CE2102: MOMENTUM TRANSFER OPERATIONS [3 1 0 4]

Newton's law of viscosity, viscometers, fluid statics, Review of Navier-Stokes' (NS) equations; non-dimensionalization of NS equations; analogies; correlations for fluid flow Short introduction to non-Newtonian flows, Engineering Bernoulli Equation; f vs. Re charts; K factors and equivalent lengths for various fittings; hydraulic diameter; Head vs. Q plots of centrifugal pumps; Net positive suction head (NPSH), cavitation and priming; pipeline system design including pseudo-steady state approximation; flow measurements; compressors and blowers. Compressible flows in conduits. Mixing and Agitation: Power consumption; mixing times; scale-up, Characterization of solids; fundamentals of two-phase flow; flow through packed beds and in fluidized beds (pressure drops, loading and flooding); pneumatic and hydraulic transportation. Filtration, Centrifuges and cyclones.

References:

1. N. de Nevers, Fluid Mechanics for Chemical Engineers, (3e), McGraw Hill Education, 2017.
2. W.L. McCabe, J.C. Smith, P. Harriott, "Unit operations of Chemical Engineering", (7e) McGraw Hill Education, 2017.
3. A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus, L.B. Andersen, Principles of Unit Operations, (2e), Wiley India, 2008.
4. J.M. Coulson, J.F. Richardson, J.R. Backhurst, J.H. Harker, Coulson and Richardson's Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer, (6e) Butterworth-Heinemann/Elsevier, 2003.
5. R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomena, (2e) John Wiley & Sons, 2006.
6. C.J. Geankoplis, Transport Processes and Separation Process Principles, (4e), Prentice Hall of India, 2015.

CE2103: CHEMICAL ENGINEERING THERMODYNAMICS [3 1 0 4]

Laws of Thermodynamics, P–V–T Relations of Pure Fluids - Graphical, Tabular and Mathematical representation; Generalized compressibility chart; Generalized EOS; Thermodynamic Potentials; Maxwell Relations, Thermodynamic Property Relations, Thermodynamic properties of real gases, Multicomponent mixtures, Properties of solutions, Phase Equilibrium (VLE, LLE, VLLE), Review of Thermochemistry; Chemical reaction equilibria.

References:

1. J. M. Smith, H. C., Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, (6e), McGraw-Hill, 2001.
2. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press, 1997.
3. B.G. Kyle, Chemical and Process Thermodynamics, (3e), PHI, 1999.

CE2104: TRANSPORT PHENOMENA [3 1 0 4]

Momentum Transport- Viscosity and mechanisms of momentum transport, shell momentum balances and velocity distribution in laminar flow, the equations of change for isothermal systems, velocity distributions with more than one independent variable, interphase transport in isothermal systems, macroscopic balances for isothermal flow systems. Energy Transport- Thermal conductivity and mechanisms of energy transport, shell energy balances and temperature distributions in solids and laminar flow, the equations of change for non-isothermal systems, temperature distributions with more than one independent variable, interphase transport in non-isothermal systems, macroscopic balances for non-isothermal systems, energy transport by radiation. Mass Transport- Diffusivity and mechanisms of mass transport, concentration distributions in solids and laminar flow, equations of change for multicomponent systems, interphase transport in non-isothermal mixtures, macroscopic balances for multicomponent systems.

References:

1. R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomena, (2e) John Wiley & Sons, 2006.
2. A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus, L.B. Andersen, Principles of Unit Operations, (2e), Wiley India, 2008.
3. C.J. Geankoplis, Transport Processes and Separation Process Principles, (4e), Prentice Hall of India, 2015.
4. W.M. Deen, Analysis of Transport Phenomena, (2e), Oxford University Press, 2013.
5. W.J. Thompson, Introduction to Transport Phenomena Prentice Hall, 1999.
6. R.S. Brodkey, H.C. Hershey, Transport Phenomena a Unified Approach, McGraw Hill Publishers, 2003.

CE2130: TRANSPORT PHENOMENA LAB I [0 0 4 2]

This course will include practical experiments for momentum transfer: venturimeter, orifice meter, Reynolds experiment, agitated vessel, rotameter, friction factor, Bernoulli's principle, centrifugal pump, and filtration.

FOURTH SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA2208: ENGINEERING MATHEMATICS IV [2 1 0 3]

Formation of Linear Programming problem, Graphical method, Simplex method, Penalty cost and two phase methods. Finite sample spaces, conditional probability and independence, Bayes' theorem. One dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential. Finite difference expressions for first and second order derivatives (ordinary and partial).Solution of BVP's in ODE. Classification of second order linear partial differential equations. Numerical solutions of two dimensional Laplace and Poisson equations by standard five point formula. Solution of one dimensional heat and wave equations by explicit methods. Crank-Nicolson method. Finite element method, Introduction, simple applications. Difference equations representing physical systems, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem.

References:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc. 1993.
2. P.L. Meyer, *Introduction to probability and Statistical applications*, 2(e), American Publishing Co 1970.
3. A Taha Hamdy, *Operation research*, (7e), Inc. Pearson Education, 2002.
4. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
5. S.S. Sastry, *Introductory methods for Numerical Analysis*, (5e), PHI Learning Private Limited, 2012.

CE2201: CHEMICAL REACTION ENGINEERING I [3 1 0 4]

Kinetics of homogeneous chemical reactions, Rate expressions, Temperature dependence of rate differential, integral, half-life and total pressure method theories, Elementary and Non elementary reaction kinetics - pseudo, steady state hypothesis mechanism. Isothermal reactor design. Design of batch, semi-batch, CSTR's and PFR's. Multiple reactor systems, reactors in series or/and parallel, CSTRs series performance analysis, batch, semi-batch, continuous and recycle reactors. Multiple reaction systems, series and parallel reactions in flow reactors, product distribution, yield and selectivity. Maximizing the desired product in parallel reactions, different reactors and schemes for minimizing the unwanted product, maximizing the desired product in series reactions. Non isothermal homogeneous reactions, temperature effects, principles of stability, design procedures for adiabatic and non-

isothermal conditions for batch semi-batch and flow reactors. Optimum temperature progression, multiple reactions and effect of temperature on product distribution.

References:

1. O. Levenspiel, *Chemical Reaction Engineering*, (3e), Wiley India Pvt Ltd., 2010.
2. H. S. Fogler, *Elements of Chemical Reaction Engineering*, (4e), Prentice-Hall of India, Delhi, 2003.
3. J. M. Smith, *Chemical Engineering Kinetics*, (3e), McGraw-Hill, 1981.
4. O. Levenspiel, *The Chemical Reactor Omnibook,* OSU Bookstores, Corvallis Oregon, 1993.
5. G. F. Froment, K. B. Bischoff, *Chemical Reactor Analysis and Design*, (3e), John Wiley and Sons, 2010.
6. Richardson, J.F., and Peacock D.G., *Coulson and Richardson's Chemical Engineering,* vol. 3, (3e), Asian Books Pvt. Ltd., New Delhi, 1998.

CE2202: HEAT TRANSFER OPERATIONS [3 1 0 4]

Introduction – Modes of heat transfer, heat transfer equipment. Conduction – Steady state conduction in one dimension, Fourier's law, thermal conductivity, steady state conduction of heat through composite solid, variable area and in bodies with heat sources. Convective heat transfer – Overall heat transfer coefficient, heat transfer between fluids separated by plane wall, cylindrical wall, thermal contact resistance, critical insulation thickness; Forced convection – flow over flat plate, thermal boundary layer, flow across a cylinder. Dimensionless groups in heat transfer, correlations for heat transfer coefficient for both internal and external flows; Free convection – heat transfer correlations, combined free and forced convection. Radiation heat transfer – Basic concepts, blackbody radiation, Planck's Law, Wien's displacement law, Stefan-Boltzmann Law, Kirchhoff's Law, grey body; Radiation intensity of black body, radiation shield, view factor, combined radiation, conduction and convection. Heat transfer in boiling and condensation – Boiling phenomena and boiling curve, mechanism of nucleate boiling, correlations for pool boiling, forced convection boiling; Condensation phenomena, condensation outside horizontal tube or tube bank, inside a horizontal tube, effect of non-condensable gases, drop wise condensation. Heat exchanger design – Double pipe heat exchanger design using Kern method, shell and tube heat exchanger design using Kern method and Bell Delaware method, effectiveness NTU method of heat exchanger analysis. Evaporators – Types of evaporators and their construction and operation, principles of evaporation and evaporators – capacity & economy, boiling point rise, heat transfer coefficient, enthalpy of solution, Evaporator selection and vapor recompression. Crystallization – Crystal geometry, principles of crystallization- equilibria & yields, nucleation, crystal growth, crystallization equipment

References:

1. Y.A. Cengel, Heat and Mass Transfer: A Practical Approach, (3e) McGraw Hill, 2006.
2. D.Q. Kern, Process Heat Transfer, McGraw Hill, 1997.
3. J. P., Holman, Heat Transfer, (10e) McGraw Hill, 2018.
4. W.L. McCabe, J.C. Smith, P. Harriott, "Unit operations of Chemical Engineering", (7e) McGraw Hill Education, 2017.
5. J.M. Coulson, J.F. Richardson, J.R. Backhurst, J.H. Harker, Coulson and Richardson's Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer, (5e) Butterworth-Heinemann/Elsevier, 2003.
6. A.J. Chapman, Heat Transfer, (4e), Persons, 2016.

CE2203: MASS TRANSFER I [3 1 0 4]

Introduction to mass transfer operations. Theory of interphase mass transfer, estimation of mass transfer coefficient, individual and overall mass transfer coefficients for gas-liquid and liquid-liquid operations. Gas Absorption, graphical calculation of number of theoretical stages for absorption and stripping column. Adsorption, adsorption isotherm, batch and continuous stage adsorption, design of adsorption column, and adsorption equipment. Vapor gas mixtures, terminology, Psychometric chart, water cooling operations, gas-liquid contact operations, adiabatic operations. Types of equipment, design calculations, cooling towers, design of cooling towers, recirculating liquid-gas humidification cooling.

References:

1. J.D. Seader, E.J. Henley, *Separation Process Principles*, (2e), Wiley, 2010.
2. R.E. Treybal*, Mass Transfer Operations,* (3e), McGraw Hill, 2012.

3. C.J. Geankoplis, *Transport Processes and Separation Process Principles*, (4e), Prentice Hall of India, 2015.
4. A.S. Foust, L.A. Wenzel, C.W. Clump, L. Maus, L.B. Andersen, *Principles of Unit Operations*, (2e), Wiley India, 2008.
5. W.L. McCabe, J.C. Smith, P. Harriott, *Unit operations of Chemical Engineering*, (7e) McGraw Hill Education, 2017.
6. R.K. Sinnott, G.Towler, Coulson & Richardson's, *Chemical Engineering Design*, Vol. 6, (5e), Elsevier, 2006.

CE2230: TRANSPORT PHENOMENA LAB II [0 0 4 2]

This course will include practical experiments for heat transfer: shell and tube heat exchanger, plate type heat exchanger, condensers, Stefan-Boltzmann's experiment, evaporator, thermal conductivity of liquid and agitated vessel.

CE2231: PROCESS EQUIPMENT DESIGN LAB [0 0 3 1]

This course will contain mechanical design of process equipment including reactors, pressure vessels, storage tank, columns, support and drawing of any two of the equipment.

FIFTH SEMESTER

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower**.** Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit**.** Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, *Essentials of Management*,(1e) Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

CE3101: MASS TRANSFER II [3 1 0 4]

Distillation, concept of vapor liquid equilibrium, Raoult's law, deviations from ideal law, azeotropic distillation and steam distillation. Enthalpy concentration diagrams, binary and multi component systems, dew and bubble point calculations, flash vaporization, simple distillation, binary component distillation, Ponchan Savarit method: minimum reflux ratio, optimum reflux ratio- total reflux ratio, partial condenser, total condenser, McCabe Thiele method: concept of q line, optimum reflux ratio- total reflux ratio, partial condenser, total condenser. Multi component distillation: azeotropic, extractive, molecular distillation. Liquid-Liquid Extraction: liquid-liquid-equilibria, ternary systems triangular and rectangular coordinates-choice of solvent-single stage and multi stage cross current, equipment's such as mixer settler, packed and tray towers. Leaching, Drying and design criteria, Design of rotary dryers.

References:

1. J.D. Seader, E.J. Henley, Separation Process Principles, (2e), Wiley, 2010.
2. R.E. Treybal, Mass Transfer Operations, (3e), McGraw Hill, 2012.
3. C.J. Geankoplis, Transport Processes and Separation Process Principles, (4e), Prentice Hall of India, 2015.
4. C.J. King, Separation Processes, (2e), Tata McGraw Hill, 1982.
5. A.H.P. Skelland, Diffusional Mass Transfer, (2e), John Wiley, 1985.

CE3102: CHEMICAL REACTION ENGINEERING II [3 1 0 4]

Isothermal non-ideal flow reactors, RTD in chemical reactors, distribution functions. Conversion in non-ideal flow reactors, single and multi-parameter models for non-ideal flow, concepts of mixing, micro and macro mixing. Heterogeneous reactions, rate equation for heterogeneous systems, contacting patterns for two phase systems, fluid particle non-catalytic reactions, different models, derivation of rate equations, application to design fluid-fluid non-catalytic reactions. Introduction to slurry reactors, trickle bed reactors, and fluidized bed reactors.

References:

1. H. S. Fogler, Elements of Chemical Reaction Engineering, (4e), Prentice-Hall of India, 2003.
2. O. Levenspiel, Chemical Reaction Engineering, (3e), Wiley India Pvt Ltd., 2010.
3. J.M. Smith, Chemical Engineering Kinetics, (3e), McGraw-Hill, 1981.
4. J. J. Carberry, Catalytic Reaction Engineering, McGraw-Hill, 1976.
5. O. Levenspiel, The Chemical Reactor Omnibook, OSU Bookstores, Corvallis Oregon, 1993.

CE3103: PROCESS MODELING AND SIMULATION [3 0 2 4]

Fundamentals and industrial applications of process modeling and simulation, macroscopic mass, energy and momentum balances, integration of fluid thermodynamics, chemical equilibrium, reaction kinetics and feed/ product property estimation in mathematical models. Steady state lumped systems, modeling of chemical process equipment (reactors, distillation, absorption, extraction columns, evaporators, and heat exchangers). Modeling and simulation of complex industrial systems in petroleum, petrochemicals, polymer, basic chemical industries; Commercial steady state and dynamic simulators; Simulation of process flow sheets.

References:

1. K. Hangos, I.T. Cameron, Process Modeling and Model Analysis, Academic Press, 2001.
2. J. Ingham, I.J. Dunn, E. Heinzle, J.E. Prenosil, J.B. Snape, Chemical Engineering Dynamics: An Introduction to Modelling and Computer Simulation, (3e), Wiley-VCH Verlag GmbH & Co. KGaA, 2007.
3. B.V. Babu, Process Plant Simulation, Oxford University Press, 2004.
4. W.L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, 1989.
5. C.D. Holland, Fundamentals and Modeling of Separation Processes, Prentice Hall, 1975.
6. D.M. Himmelblau, K.B. Bischoff, Process analysis and simulation: Deterministic systems, John Wiley, 1968.

CE3104: PROCESS SAFETY ANALYSIS [3 1 0 4]

Introduction – Accident and loss statistics, inherent safety, safety culture, ethics; Toxicology- How toxicants enter and are eliminated from biological organisms, toxicological studies, dose vs response, relative toxicity, threshold limit values; Industrial Hygiene: Government regulations, identification, evaluation of exposures to volatile toxicants, dusts, noise, toxic vapors, control; Source Models: Flow of liquid through hole, hole in a tank, pipes; Flow of vapor through holes, gases through pipes; Flashing liquids, liquid pool evaporation or boiling, toxic release and dispersion models; Fires and explosion: Fire triangle, fire vs explosion, flammability characteristics of liquid and vapors, TNT equivalency, energy of chemical and mechanical explosions, vapor cloud explosions, BLEVE, inerting, static electricity, explosion proof equipment and instruments, sprinkler systems; Relief systems: Relief concepts, location of reliefs, relief scenarios, relief systems for flares, scrubbers, condensers, knock out drum; Relief sizing: Spring operated for liquid/vapor/gas service, rupture disk relief for liquid/vapor/gas, reliefs for thermal expansion of process fluids; Hazard Identification: Surveys, HAZOP, safety reviews Risk assessment: Probability theory, event trees, fault trees, QRA, LOPA, Accident investigations

References:

1. D.A. Crowl, J.F. Louvar, Chemical Process Safety, (3e), Pearson, 2015.
2. Center for Chemical Process Safety (CCPS), Introduction to Process Safety for Undergraduates and Engineers, Wiley, 2016.
3. R.E. Sanders, Chemical Process Safety, (3e), Elsevier, 2006.
4. J.A. Klein, B.K. Vaughen, Process Safety: Key Concepts and Practical Approaches, CRC press, 2017.

CE3130: TRANSPORT PHENOMENA LABORATORY III [0 0 4 2]

This course will include practical experiments for mass transfer: Vapour Liquid equilibrium, distillation, liquid-liquid extraction, leaching, crystallization, leaching, drying, and mass transfer with and without reaction.

SIXTH SEMESTER

CE3201: PROCESS PLANT DESIGN [3 1 0 4]

Process Design and Development: The hierarchy of chemical process design, general design considerations, nature of process synthesis and analysis. Development of a conceptual design and determining the best flow sheet: input information and batch versus continuous, Input/output structure of the flow sheet; Recycle structure of flow sheet; Separation system; Heat Exchanger Networks. Plant Design: Process design development and general design considerations. Process Economics: Economic feasibility of project using order-of-magnitude cost estimates, plant and equipment cost estimation, product cost estimation.

References:

1. J. M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, 1988.
2. M.S. Peters, K.D. Timmerhaus, R.E. West, Plant Design and Economics for Chemical Engineers, (5e), McGraw-Hill, 2003.
3. W.D. Seider, J.D. Seader, D.L. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, (3e), John-Wiley and Sons, 2008.
4. R. Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiwitz, D. Bhattacharyya, Analysis, Synthesis and Design of Chemical Processes, (4e), Prentice Hall India Learning Private Limited, 2015.
5. G. Towler R.K. Sinnott., Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design, CBSPD, 2009.
6. D.F. Rudd, C.C. Watson, Strategy of Process Engineering, John Wiley and Sons, 1968.
7. A.W. Westerberg, H.P. Hutchison, R.L. Motard, P. Winter, Process Flowsheeting, Cambridge University Press, 2011.

CE3202: CHEMICAL PROCESS INDUSTRIES [3 1 0 4]

Overview of typical chemical processes, unit operations and unit processes, Indian chemical process industries, inorganic chemical industry, study aspects of chemical process industries- raw materials, process, chemical reactions, process and block flow diagram, major engineering issues and uses of industries for water conditioning and treatment, common salt (NaCl) manufacture, coal gasification, manufacture of ammonia, urea, nitric acid and ammonium nitrate.

References:

1. G.M. Rao, M. Sitting, Dryden's Outlines of Chemical Technology – for the 21st Century, (3e), East-West Press, 1997.
2. G.T. Austin, Shreve's Chemical Process Industries (5e), Tata McGraw-Hill, 2012.
3. P.H. Groggins, Unit processes in organic synthesis (5e), McGraw-Hill, 2004.

CE3203: PROCESS DYNAMICS AND CONTROL [3 1 0 4]

Introduction to process control, Laplace transforms. Linear open-loop systems, First-Order Systems: transfer function, transient response (step response, impulse response, and sinusoidal response), and response of first-order systems in series: non-interacting systems and interacting systems. Second-Order Systems: transfer function, step response, impulse response, sinusoidal response, transportation lag. Linear closed-loop systems. Control system: components of a control system, block diagram, negative feedback and positive feedback, servo problem and

regulator problem. Controller transfer functions (P, PI, PD, PID), controller tuning. Advanced Control Schemes: cascade, feed-forward, ratio control, dead-time compensation, internal model control. Instrumentation: final control element, measuring devices for flow, temperature, pressure and level.

References:

1. D.R. Coughanowr, Process Systems Analysis and Control, (3e), McGraw Hill, 2008.
2. D.E. Seborg, D.A. Mellichamp, T.F. Edgar, Process Dynamics and Control, (3e), John Wiley & Sons, 2010.
3. C.D. Johnson, Process control instrumentation technology, Prentice-Hall, 2006.
4. G. Stephanopoulos, Chemical Process Control, PHI, 2008.
5. W.L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, (2e), McGraw Hill, 1990.

CE3230: CHEMICAL REACTION ENGINEERING LAB [0 0 4 2]

This course will include practical experiments for reaction engineering: Plug flow reactor (PFR), continuous stirred tank reactor (CSTR), CSTR in Series, combination of reactors, gas-solid reactions and photochemical reactor.

CE3231: PROCESS DYNAMICS AND CONTROL LAB [0 0 4 2]

This course will include practical experiments for Process Dynamics and Control: first order system, second order system, valve characteristics, and computational process control.

SEVENTH SEMESTER

CE4170: MINOR PROJECT [0 0 4 2]

The minor project will be carried out by the student at the university (on campus). It may include but not limited to literature survey, case study, experimental or simulation studies. It will be done individually or in a group.

CE4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a period of 4-6 weeks. This may be taken in a phased manner during the vacation starting from the end of sixth semester. Student has to submit to department a training report in the prescribed format and also make a presentation of the same. The report should include the certificate issued by the industry.

EIGHT SEMESTER

CE4270: MAJOR PROJECT [0 0 0 12]

The project work may be carried out in the institution/industry/research laboratory or any other competent institution. The duration of the project work shall be minimum of 16 weeks which may be extended up to 24 weeks.

PROGRAM ELECTIVE-I

CE3240: ENGINEERING MATERIALS [3 0 0 3]

Structure of materials-crystal structure, substructure, microstructure; Materials classifications –engineering standards, material selection (CES type packages); Material properties – mechanical, electrical, physical, corrosion, etc. properties; Material treatment –heat treatment, various types of heat treatment such as annealing, normalizing, quenching, tempering (Austempering, Martempering), and various case hardening processes, surface treatment, etc.; Ferrous materials-various types of carbon steels, alloy steels and cast irons, its properties and uses, effects of different alloying elements, super alloys; Non-Ferrous metals and alloys-non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications, Various type of Brass and Bronze, bearing materials, its properties and uses. Aluminum alloys such as Duralumin; Ceramics – classification, characterization, properties; Plastics – Various types of polymers/plastics and its applications, Mechanical behaviour and processing of plastics, Future of plastics; Composite materials – structure, properties, classification, processing; other materials: brief description of other material such as optical and thermal materials, Introduction to smart materials & nano-materials and their potential

applications; Electric properties, Semiconductors and Super conductors- Energy band concept of conductor, insulator and semi-conductor. Intrinsic & extrinsic semi-conductors. Super conductivity and its applications; Magnetic Properties: concept of magnetism - dia, para, ferro hysteresis. Soft and hard magnetic materials; Surface engineering and applications – techniques, coatings, processing and heat treatment.

References:

1. W.D. Callister, D.G. Rethwisch, R. Balasubramaniam, Callister's Material Science and Engineering, (2e), Wiley India Pvt Ltd., 2014.
2. W.F. Smith, J. Hashemi, R. Parkash, Material Science and Engineering, McGraw Hill, 2014.
3. V. Raghvan, Materials Science and Engineering, (5e), PHI Learning, 2013,
4. F.J. Shackelford, Introduction to Materials Science for Engineers, (7e), Pearson Prentice Hall, 2009.
5. L.H. Van Vlack, Elements of Material Science and Engineering, (6e), Pearson, 2002

CE3241: PROCESS SYNTHESIS [3 0 0 3]

Introduction to Process Systems Engineering; Strategy of Reaction Synthesis; Engineering Data on Reaction Paths; Screening of Reaction Paths; Reaction Paths with Recycle; Conservation of Mass; Material Balancing Pathways; Synthesis of Material Flow; Species Allocation; Introduction to Separation Technology; Solid-Solid separation methods; Liquid-Liquid separation techniques; Reduction of Separation Load; Selection of Separation Phenomena; Integration of Auxiliary Operations; Energy Balance; Sensible and Latent Heat; Heat of Chemical Reactions; Heat energy management and Heat-Exchanger Networks; Case studies from chemical and petroleum processing plants.

References:

1. D.F. Rudd, G.J. Powers, J.J. Siirola, Process Synthesis, Prentice-Hall international series in the physical and chemical engineering sciences, 1973.
2. R.M. Murphy, Introduction to Chemical Processes: Principles, Analysis, Synthesis, Mc Graw Hill, 2017.
3. R. Smith, Chemical Process: Design and Integration, John Wiley & Sons, 2005.
4. W.D. Seider, J.D. Seader, D.L. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, (3e), John-Wiley and Sons, 2008.
5. R. Smith, Chemical Process Design, McGraw-Hill, New York, 1995.

PROGRAM ELECTIVE-II

CE3242: BIOPROCESS ENGINEERING [3 0 0 3]

Basics of biology and bioprocess engineering. Microbial growth and kinetics. Enzymes and enzyme kinetics. Bioreactor Engineering, Fermentation mechanisms and kinetics. Types of fermenters, modeling of batch and continuous fermentor. Bioreactor design and mixing phenomena. Sterilization of media and air, sterilization equipment and design. Downstream Processing (Recovery and Purification of Products): membrane separation processes, chromatographic methods, and electrokinetic separations: electro-dialysis, electrophoresis. Waste water treatment: activated sludge process, anaerobic digestion, trickling filter.

References:

1. M.L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, (2e), Prentice Hall of India, 2017.
2. J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, (2e), McGraw Hill, 2017.
3. P. Doran, Bioprocess Engineering Principles, (2e), Elsevier, 2012.
4. K. Schugerl, K.V. Bellgardt, Bioreaction Engineering: Modeling and Control, Springer Verlag, Heidelberg, 2000.
5. S. Aiba, A.E. Humphrey, N.F. Millis, Biochemical Engineering, (2e), Academic Press, 1973.
6. H.W. Blanch, D.S. Clark Biochemical Engineering, (2e), CRC Press, New York, 1997.

CE3243: CATALYTIC PROCESSES [3 0 0 3]

Introduction to history of catalysis, catalytic processes in industry, chemical kinetics of catalyzed reactions: rate expression, adsorption isotherms, temperature and pressure dependency. Heterogeneous catalysis: industrial reactors, ideal reactors, reaction combined with transport, reaction kinetics determination. Introduction to Homogenous catalysis with transition metal complexes, catalysts testing and reactors configurations, catalyst

deactivations, mechanism and kinetics study, kinetic modeling and parameter estimations, Preparation of catalyst supports and mesoporous materials, supported catalysts, catalyst characterization techniques.

References:

1. R.A. Van Santen, P.W.N.M. Van Leeuwen, J.A. Moulijn, B.A. Averill, Catalysis: An integrated Approach, (2e), Elsevier, Amsterdam, 1999.
2. G. Ertl, H. Knozinger, J. Weitkamp, Handbook of Heterogeneous Catalysis, Vol 1-5, (2e) Wiley – VCH, 2008.
3. B. Viswanathan, S. Sivasanker, A.V. Ramaswamy, Catalysis: Principles & Applications, CRC Press, 2002.
4. J. M. Smith, Chemical Engineering Kinetics, (3e), McGraw-Hill, 1981.
5. J.J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw Hill, 1976.
6. C.H. Bartholomew, R.J. Farrauto, Fundamentals of Industrial Catalytic Processes, (2e), Wiley- VCH, 2005.

PROGRAM ELECTIVE-III

CE4140: PETROLEUM PRODUCTION TECHNOLOGIES [3 0 0 3]

Introduction to exploration and onshore/offshore production facilities and processes, oil, natural gas and produced water properties for designing and analyzing oil and gas production systems. Performance of oil and gas wells such as reservoir deliverability, wellbore performance, choke performance, well deliverability. Production enhancement-matrix acidizing, hydraulic fracturing Equipment design- well tubing, separation systems, transportation systems.

References:

1. B. Guo, W.C. Lyons, A. Ghalambor, Petroleum Production Engineering, A Computer Assisted Approach, Gulf Professional Publishing, 2011.
2. M.J. Economides, A.D. Hill, C. Ehlig-Economides, D. Zhu, Petroleum Production Systems, (2e), Prentice Hall, 2012.
3. W. Lyons, Working Guide to Petroleum and Natural Gas Production Engineering, Gulf Professional Publishing, 2010.
4. H.K. Abdel, M. Aggour, M. A. Fahim, Petroleum and Gas Field Processing, Marcel Dekker, 2003.

CE4141: CONVENTIONAL AND NON-CONVENTIONAL ENERGY RESOURCES [3 0 0 3]

Introduction of coal, natural gas and oil as sources of energy. Introduction to world energy scenario. Application of coal in industries. *In situ* coal Gasification. Oil and Gas from condensate and oilfields. Scope of Oil and Natural gas industry. Concepts of thermodynamics and system energy in Natural Gas Engineering. Physical properties of natural gas and the associated hydrocarbon liquids. Reservoir aspects of natural gas and oil. Conversion of coal and gas to liquid. Renewable energy resources, radiation, solar geometry, radiation models; Solar thermal, optical efficiency, thermal efficiency, concentrators, testing procedures, introduction to thermal systems (flat plate collector), biomass, biomass resources, wood composition, biogas, biodiesel, ethanol; Wind, types of wind machines, hydro resources, types of hydro turbine, small hydro systems; Other systems, geothermal, wave energy, ocean energy.

References:

1. R. F. Probstein, R.E. Hicks, Synthetic Fuels, Dover Publications, 2013.
2. D.D. Hall, R.P. Grover, Biomass: Regenerable Energy, John Wiley & Sons, 1987.
3. T. Twidell, T. Weir, Renewable Energy Resources, E & F N Spon Ltd, 1986.
4. J.A. Duffie, W.A. Beckman, Solar Engineering of Thermal Processes, (4e), John Wiley, 2013.

PROGRAM ELECTIVE-IV

CE4142: PETROLEUM REFINERY OPERATIONS [3 0 0 3]

Petroleum resources, petroleum industry in India. Composition and classification of petroleum crude, ASTM, TBP and FEV distillation. Properties and specifications of petroleum products – LPG, Gasoline, naphtha, kerosene, diesel oil, lubricating oil, wax etc. Design and operation of topping and vacuum distillation units. Tube still furnaces. Solvent extraction processes for lubricating oil base stocks and for aromatics from naphtha and kerosene, solvent dewaxing. Thermal and catalytic cracking, vis-breaking and coking processes, reforming, hydro processing, alkylation, polymerization and isomerization. Safety and pollution considerations in refineries.

References:

1. J.H. Gary, G.E., Handwerk, Petroleum Refining, Technology and Economics, (5e), CRC Press, 2007.
2. W. L. Nelson, Petroleum Refinery Engineering, (4e), McGraw Hill, 1987.
3. B.K.B. Rao, Modern Petroleum Refining Processes, Oxford-IBH, 2008
4. R.N. Watkins, Petroleum Refinery Distillation, (2e), Gulf Publishing, 1979.
5. K.A. Kobe, J.J. McKetta, Advances in Petroleum Chemistry and Refining, Wiley Interscience, 1958.

CE4143: ENVIRONMENTAL SYSTEMS ENGINEERING [3 0 0 3]

Characterization of Industrial wastewater, primary, secondary and tertiary treatment, segregation, screening, equalization, coagulation, flocculation, precipitation, flotation, sedimentation, aerobic treatment, anaerobic treatment, absorption, ion exchange, membrane filtration, electro dialysis, sludge dewatering and disposal methods. Sources and classification of air pollutants, nature and characteristics of gaseous and particulate pollutants, pollutants from automobiles. Air pollution meteorology, plume and its behavior and atmospheric dispersion, control of particulate emissions by gravity settling chamber, cyclones, wet scrubbers, bag filters and electrostatic precipitators. Control of gaseous emissions by absorption, adsorption, chemical transformation and combustion. Hazardous and non-hazardous waste, methods of treatment and disposal, land filling, leachate treatment and incineration of solid wastes.

References:

1. M.L. Davis, D.A. Cornwell, Introduction to Environmental Engineering, (5e), McGraw-Hill, 2014.
2. G. Tchobanoglous, F.L. Burton, H.D. Stensel Wastewater Engineering: Treatment and Reuse, (4e), McGraw-Hill, 2003.
3. G.M. Masters, W.P. Ela, Introduction to Environmental Engineering and Science, Pearson Education Inc., 2015.
4. H. S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw Hill, 2013.
5. S.C. Bhatia, Environmental Pollution and Control in Chemical Process Industries, Khanna Publishers, Delhi, 2001.
6. H.C. Perkins, Air Pollution, McGraw Hill, 1974.

PROGRAM ELECTIVE-V

CE4144: PETROCHEMICAL PRODUCTION TECHNOLOGIES [3 0 0 3]

Survey of petrochemical industry; Availability of feed stocks; Production, purification and separation of feed stocks; Methane and synthesis gas derivatives, Ethylene and Ethylene derivatives, Propylene and propylene derivatives, Chemicals from C_2, C_3, C_4 and higher carbon compounds, Oxo reactions, etc. Production of chemicals from acetylene; Catalytic reforming of naphtha and isolation of aromatics; Chemicals from aromatics and BTX derivatives; Polymers, elastomers, polyurethanes, Synthetic fibers, detergents, rubbers and plastics; Petroleum coke.

References:

1. B.K.B. Rao, A Text on Petrochemicals, (2e), Khanna publishers, 1996.
2. I.D. Mall, Petrochemical Process Technology, Mac Millan India Ltd, 1997.
3. S. Matar, L.F. Hatch, Chemistry of Petrochemical Processes, (2e), Gulf Publishers, 2001.

CE4145: ENERGY AND PROCESS INTEGRATION [3 0 0 3]

Introduction: energy targeting and the pinch principle, problem table, cascade diagram, composite / grand composite curves, pinch point, utility pinch; Maximum Energy Recovery Network – pinch design method, grid\diagram, stream splitting / matching; Evolution / Evaluation of Networks – Euler's principle, identification and breaking of loops using paths; Capital cost targeting, Continuous Targeting – area / cost targeting, vertical heat transfer, threshold problem, super targeting; Distillation Column Targeting Principles, grand column composite curves, column composite curves, evaluation of energy saving options; Introduction to heat and power systems.

References:

1. U.V. Shenoy, Heat exchanger network synthesis: Process optimization by energy and resource analysis, Gulf publishing, 1995.
2. J. M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, 1988.

3. W.D. Seider, J.D. Seader, D.L. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, (3e), John-Wiley and Sons, 2008.
4. I.C. Kemp, Pinch analysis and process integration: A user guide on process integration for the efficient use of energy, (2e) Butterworth-Heinemann, 2006.
5. J. J. Klemes, P.S. Varbanov, S.R.W.W. Alwi Z.A. Manan, Process Integration and Intensification: Saving Energy, Water and Resources, (2e), De Gruyter, 2014.

PROGRAM ELECTIVE-VI

CE4146: PROCESS OPTIMIZATION [3 0 0 3]

Formulation of the objective function. Unconstrained single variable optimization: Newton, Quasi-Newton methods, polynomial approximation methods. Unconstrained multivariable optimization: Direct search method, conjugate search method, steepest descent method, conjugate gradient method, Newton's method. Linear Programming: Formulation of LP problem, graphical solution of LP problem, simplex method, duality in Linear Programming, two-phase method. Nonlinear programming with constraints: Necessary and sufficiency conditions for a local extremum, Quadratic programming, successive quadratic programming, Generalized reduced gradient (GRG) method. Use of MS-Excel and MATLAB for solving optimization problems. Introduction to global optimization techniques. Applications of optimization in Chemical Engineering.

References:

1. T.F. Edgar, D.M. Himmelblau, L.S. Ladson, Optimization of Chemical Process, (2e), McGraw-Hill, 2001.
2. C.O. Godfrey, B.V. Babu, New Optimization Techniques in Engineering, Springer-Verlag, Germany, 2004.
3. G.S. Beveridge, R.S. Schechter, Optimization Theory and Practice, McGraw- Hill, New York, 1975.
4. G.V. Reklaitis, A. Ravindran, K. Ragsdell, M., Engineering Optimization-Methods and Applications, (2e) Wiley India Pvt Ltd., 2006.

CE4147: PROCESS ECONOMICS AND MANAGEMENT [3 0 0 3]

Cash flow concepts, present future and annual values, net present value, present value ratio, rate of return, breakeven, depreciation and taxes, project definition, project network, scheduling resource and cost, managing project risk, project progress, performance measurement, and evaluation.

References:

1. F.J. Stermole, J.M. Stermole, Economic Evaluation and Investment Decision Methods, and Investment Evaluation Corporation, (15e) Golden CO (USA), 2014.
2. H.A. Taha, Operations Research: An Introduction, (2e), Prentice Hall, 1997.

PROGRAM ELECTIVE-VII

CE4148: PROCESS INTENSIFICATION [3 0 0 3]

Introduction to process intensification (PI): sustainability related issues in process industry; definitions of process intensification; fundamental principles and approaches of PI; design of a sustainable and inherent safer processing plants. Mechanisms involved in PI: intensified heat transfer, intensified mass transfer, electrically enhanced processes, micro fluidics; compact and micro heat exchangers; Reactors: reactor engineering theory, spinning disc reactors, oscillatory baffled reactors, micro reactors, reactive separations, membrane reactors, supercritical operations, field enhanced reactors, rotating fluidized beds. Intensification and Separation Processes: distillation (reactive, extractive), centrifuges, membranes, drying, precipitation and crystallization; Intensified mixers, PI case study.

References:

1. D. A. Reay, C. Ramshaw, A.P. Harvey, Process Intensification: engineering for efficiency, sustainability and flexibility, (2e), (IChemE) Butterworth Harriman, London, 2008.
2. A. Stankiewicz, J.A. Moulijn, (Eds), Re-Engineering the Chemical Processing Plant: Process Intensification, CRC Press, 2003.
3. J.G. Segovia-Hernandez, A. Bonilla-Petriciolet, (Eds), Process Intensification in Chemical Engineering Design Optimization and Control, Springer, 2016.

4. F.J. Keil, (Ed), Modelling of Process Intensification, Wiley International, 2007.
5. A.A. Kiss, Process Intensification Technologies for Biodiesel Production, Springer, 2014.
6. H. Mothes, Process Design Synthesis, Intensification and Integration of Chemical Processes, Manufective, 2015.

CE4149: ADVANCED SEPARATION TECHNOLOGIES [3 0 0 3]

Separation process in chemical and biochemical industries, categorization of separation processes, equilibrium and rate governed processes. Introduction to various new separation techniques e.g. Membrane separation, ion-exchange foam separation, supercritical extraction, liquid membrane permeation, PSA & Freeze drying. Membrane based separation technique (MBSTs). Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. Osmosis and osmotic pressure. Working principle, operation and design of Reverse osmosis, Ultrafiltration, Microfiltration, Electrodialysis and Pervaporation. Gaseous separation by membranes. Ion Exchange, basic principle and mechanism of separation, Ion exchange resins, regeneration and exchange capacity. Exchange equilibrium, affinity, selectivity and kinetics of ion exchange. Design of ion exchange systems and their uses in removal of ionic impurities from effluents. Introduction to foam separation, micellar separation, supercritical fluid extraction, liquid membrane permeation and chromatographic separations.

References:

1. C.J. King, Separation Processes, (2e), Dover Publishers, 1982.
2. S. Sourirajan, T. Matsura, Reverse Osmosis and Ultra-filtration - Process Principles, NRC Publications, 1985.
3. M.C. Porter, Handbook of Industrial Membrane Technology, Noyes Publication, 1990.
4. J.D. Henry, N.N. Li, New Separation Techniques, AIChE Today Series, AIChE 1975.
5. T. A. Hatton, J.F. Scamehorn, J.H. Harvell, Surfactant Based Separation Processes, Vol. 23, Surfactant Science Series, Marcel Dekker Inc.,1989.
6. M.A. McHugh, V.J. Krukonis, Supercritical Fluid Extraction, Butterworths,1985.

OPEN ELECTIVES

CE2280: MATERIAL SCIENCE ENGINEERING AND APPLICATIONS [3 0 0 3]

Introduction to solid state Physics and Chemistry: Crystalline and amorphous solids, crystal structure, bonding in solids, crystal imperfections, thermodynamics of solids, diffusion in solids. Chemical analysis of materials: X-ray diffraction, electron diffraction, neutron diffraction, introduction to surface science, Fourier transform infrared spectroscopy, Raman Spectroscopy, X-ray photoelectron spectroscopy, scanning electron microscope, transmission electron microscope, energy dispersive X-ray spectroscopy, X-ray florescence, luminescence. Physical Metallurgy: Phase rule, phase transformation (fundamentals of crystallization), corrosion of metals, theories and types of corrosion, preventive measures against corrosion, ferrous alloys, steels and its types, non-ferrous alloys (including aluminum, copper, nickel, magnesium, titanium) and processing of metals. Polymeric Materials: Polymer science and process of polymerization, types of polymers, carbon-based polymers, biocompatible and biodegradable polymers, self-healing polymers, elastomers and processing of polymeric materials. Ceramic Materials: Crystalline and Non-crystalline ceramic materials, classification of ceramics materials, ceramic phase diagram, mechanical properties of ceramics, cements, processing of ceramic materials. Reinforced materials (polymers and concrete): Particle reinforced materials, fiber reinforced materials, mechanical properties of reinforced materials. Material Properties and Applications: Electrical properties, magnetic properties, thermal properties, semiconductor properties and optical properties of materials and their respective applications. Nanotechnology and Nanomaterials: Introduction to nanomaterials, top-down and bottom-up approach for nanomaterial synthesis (crystallization), nanostructure materials, carbon nanotechnology, semiconductor nanomaterials, metallic nanomaterials, nanomaterials for biomedical, chemical, electronics and mechanical applications.

References:

1. W.F. Smith, J. Hashemi, R. Prakash, “Material Science and Engineering”, (5e), McGraw Hill Publishers, 2014.
2. W.D. Callister Jr., D.G. Rethwisch, R. Balasubramaniam, “Callister’s Material Science and Engineering”, (2e), Wiley India Pvt. Ltd., 2014.

3. J.F. Shackelford, M.K. Muralidhar, “Introduction to Material Science for Engineers”, (6e), Pearson India, 2007.
4. K. Raghavan, “Materials Science and Engineering: A First Course”, (6e), Prentice Hall of India, 2015.
5. M. Fontana, “Corrosion Engineering”, (3e), McGraw Hill Publishers, 2005.
6. H.L. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr., “Instrumental Methods of Analysis”, 7ed, CBS Publishers and Distributers, 1986.

CE3180: CORROSION ENGINEERING [3 0 0 3]

Introduction: What is corrosion? Need for corrosion prevention, Economic loss due to corrosion, environment of corrosion, Corrosion Engineering. Electrochemistry: Thermodynamics related to corrosion, Solution thermodynamics, activity related to ionic species, cell potential and EMF Series, potential-pH (Pourbaix) diagram, electrode kinetics. Chemical Engineering Fundamentals: Diffusion, Fick’s law, Rate of reaction, Arrhenius Law, temperature dependence of reaction. Corrosion Principles: rate expression for corrosion, electrochemical aspects, environmental effects, Metallurgical and Other aspects. Forms of Corrosion: Galvanic, Crevice, Pitting, Intergranular, Erosion, Stress corrosion, Selective leaching, Hydrogen damage. Corrosion Testing. Materials: Metals and Alloys, Non-metals, Thermoplastics, Thermosetting plastics and others. Corrosion Prevention: Material Selection, Alteration of Environment, Design, Cathodic and Anodic Protection, Coatings. Handling of Mineral Acids: Sulfuric acid, Nitric Acid, Hydrochloric acid, Hydrofluoric acid, Phosphoric acid. Corrosion due to other environments. Modern Theory of Corrosion Prevention: Predicting corrosion behavior, corrosion prevention, Corrosion rate measurement. High Temperature corrosion: Mechanism and kinetics, High Temperature Materials, Metal-gas reactions.

References:

1. M.G. Fontana, Corrosion Engineering, (3e), McGraw Hill Publishers, 1967
2. S. Glasstone, An Introduction to Electrochemisty, Affiliate East West Press Private Limited, 2017
3. P. Atkins, J. de Paula, J. Keeler, Atkins’ Physical Chemistry, (11e), Oxford University Press, 2018
4. D.A. Jones, Principles and Prevention of Corrosion, (2e), Pearson, 1995.

CE3280: RENEWABLE AND NON-RENEWABLE ENERGY RESOURCES [3 0 0 3]

Introduction of coal, natural gas and oil as sources of energy. Application of coal in industries. Coal Gasification. Oil and Gas from condensate and oilfields, Oil and Natural gas industry. Physical properties of natural gas and the associated hydrocarbon liquids. Reservoir aspects of natural gas and oil. Conversion of coal and gas to liquid. Carbon capture and Storage. Renewable energy resources, radiation, solar geometry, radiation models; Solar thermal, optical efficiency, thermal efficiency, concentrators, testing procedures, introduction to thermal systems (flat plate collector), biomass, biomass resources, wood composition, biogas, biodiesel, ethanol; Wind, types of wind machines, hydro resources, types of hydro turbine, small hydro systems; Other systems, geothermal, wave energy, ocean energy, Fuel Cell.

References:

1. R. F. Probstein, R.E. Hicks, Synthetic Fuels, Dover Publications, 2013.
2. D.D. Hall, R.P. Grover, Biomass: Regenerable Energy, John Wiley & Sons, 1987.
3. T. Twidell, T. Weir, Renewable Energy Resources, E & F N Spon Ltd, 1986.
4. J.A. Duffie, W.A. Beckman, Solar Engineering of Thermal Processes, (4e), John Wiley, 2013.

Department of Civil Engineering

The Department of Civil Engineering was established in 2011. The department offers UG, PG and Doctoral Programs. Over the years the department is aiming to provide quality education and nurturing young minds to produce bright civil engineers in the country. The department offers all kind of support such as basic to advanced practical training; exposure with contemporary and futuristic technologies; providing opportunities for projects and research works; and extra-curricular activities. The department has expertise in almost the entire domain of Civil Engineering, offering higher degree programs in Structural Engineering, Environmental Engineering, Geotechnical Engineering, Water Resources Engineering, Transportation Engineering and Geomatics. The department has well-equipped laboratories where many of our faculty members and students are involved in research activities in various areas of civil engineering. The department has been constantly involved in a range of research and consultancy projects funded by reputed National and International agencies and in collaboration with IIT's. The department is also very active in conducting conferences, workshops, short-term courses, and seminars. Student's clubs and professional student chapters such as Green club, Institute of Engineers (IEI) Student Chapter and Indian Concrete Institute (ICI) Student Chapter engage in organizing several academia-industry expert lectures, alumni meets, software training programs, internship drives and other societal activities. Further, the departmental academia/ industry connect enables student placements in organizations in India as well as higher studies abroad.




B.Tech in Civil Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value, Ethics and Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA2104	Engineering Mathematics – III	2	1	0	3	MA2207	Engineering Mathematics – IV	2	1	0	3
	CV2101	Fluid Mechanics	3	1	0	4	CV2201	Engineering Geology	3	0	0	3
	CV2102	Building Materials & Construction Technology	3	1	0	4	CV2202	Water Supply Engineering	3	1	0	4
	CV2103	Surveying	3	1	0	4	CV2203	Analysis of Indeterminate Structures	3	1	0	4
	CV2104	Structural Analysis	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	CV2130	Material Testing Lab	0	0	2	1	CV2230	Geology Lab	0	0	2	1
	CV2131	Surveying Lab	0	0	3	1	CV2231	Fluid Mechanics Lab	0	0	2	1
							CV2232	Building Drawing and Design	1	0	3	2
			16	5	5	23			18	3	7	24
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P) + OE		28			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	BB0026	Organisation and Management	3	0	0	3	CV3201	Applied Geotechnical Engineering	3	1	0	4
	CV3101	Geotechnical Engineering	3	1	0	4	CV3202	Design of Steel Structures	3	1	0	4
	CV3102	Highway Engineering	3	1	0	4	CV3203	Railways and Airport Engineering	2	1	0	3
	CV3103	Design of Reinforced Concrete Structures	3	1	0	4	CV32XX	Program Elective – I	3	0	0	3
	CV3104	Waste Water Management	3	1	0	4	CV32XX	Program Elective – II	3	0	0	3
	XXXXXX	Open Elective – II	3	0	0	3	XXXXXX	Open Elective – III	3	0	0	3
	CV3130	Geotechnical Engineering Lab	0	0	2	1	CV3230	Computer Aided Design Lab	0	0	2	1
	CV3131	Environmental Engineering Lab	0	0	2	1	CV3231	Highway Engineering Lab	0	0	2	1
							CV3232	Waste Management Lab	0	0	2	1
							CV3233	Estimation and Costing Practice	0	0	3	1
			18	4	4	24			17	3	9	24
	Total Contact Hours (L + T + P) + OE		26				Total Contact Hours (L + T + P) + OE		29			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	CV41XX	Program Elective – III	2	1	0	3	CV4270	Major Project	0	0	0	12
	CV41XX	Program Elective – IV	2	1	0	3						
	CV41XX	Program Elective – V	2	1	0	3						
	CV41XX	Program Elective – VI	2	1	0	3						
	CV41XX	Program Elective – VII	2	1	0	3						
	CV4170	Minor Project	0	0	3	1						
	CV4171	Industrial Training	0	0	2	1						
	CV4172	Survey Camp	0	0	3	1						
			10	5	8	18						12
	Total Contact Hours (L + T + P)		23				Total Credit= 169(including first year)					

THIRD SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects. CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B. N. Ghosh, *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. S. K. Mandal, *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. C. K. Ray, *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Abha Chatterjee, *Professional Ethics*, (2e) Oxford Publications.

MA2104: ENGINEERING MATHEMATICS III [2 1 0 3]

Gradient, divergence and curl. Line, surface and volume integrals. Green's, Gauss divergence and Stokes' theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions. Introduction to probability: finite sample space, conditional probability and independence. Bayes' theorem, One dimensional random variables: Mean and variance. Two and higher dimensional random variables: mean, variance, correlation coefficient and regression

References:

1. R. Spiegel Murray, *Vector Analysis*, Schaum Publishing Co., 1959.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, (9e), Wiley Eastern, 2006.
3. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.
4. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.

CV2101: FLUID MECHANICS [3 1 0 4]

Introduction, Fluid Properties and Classification of Fluid, Pressure and its Measurement using manometers, Hydrostatics, Kinematics of Fluid Motion, Dynamics of Fluid Motion, Laminar Flow, Turbulent Flow, Flow Measurement, Dimensional Analysis, Flow in open Channels, Gradually varied flow rapidly varied flow.

References:

1. V. L. Streeter, E. B Wiley, *Fluid Mechanics*, McGraw Hill book Co., New York. 1998
2. A. Çengel Yunus, John M Cimbala, *Fluid Mechanics Fundamentals and Applications*, Tata McGraw Hill Education Pvt. Limited New Delhi, 2011
3. P. N. Modi, S. M. Seth, *Hydraulics and Fluid Mechanics*, Standard Book House, New Delhi. 2005
4. R. K. Bansal, *Fluid Mechanics and Hydraulic Machines*, Laxmi Publishers, New Delhi. 2010
5. R.J. Garde, *Fluid Mechanics through problems*, New age international Pvt. Ltd., Publishing, New Delhi. 2003

CV2102: BUILDING MATERIALS & CONSTRUCTION TECHNOLOGY [3 1 0 4]

Building Materials: Lime; Bricks; Tiles; Tar; FRP; Glass; Ferro-cement; Ceramics; Paints; Timber. Cement – Types, composition, properties and uses, physical tests on cement. Concrete: Ingredients and production, properties & tests on fresh and hardened concrete as per IS codes. Construction Technology: Classification of buildings, load bearing

and framed structure; Sequence of construction activity; building components and its type, viz. foundations (shallow and deep), flooring, stairs, arches & lintels, roofs (trusses); Brick and Stone Masonry; Damp Proofing; Construction joints; Temporary structural support viz. shoring, shuttering, underpinning and scaffolding; Fabrication and Erection work; Construction practices for plastering, pointing, painting, flooring.

References:

1. B. C. Punmia, A. K. Jain, A. K. Jain, *Building Construction*, Laxmi Publications, 11th Edition, 2016.
2. A. M. Neville, *Properties of Concrete*, McGraw-Hill, Singapore, 2012.
3. SP 20, *Handbook on Masonry Design and Construction*, B.I.S. Publication, 1991.
4. SP 62 (S&T), *Handbook on Building Construction Practices*, B.I.S. Publication, 1997.
5. B. C. Punmia, *Building Construction*, Lakshmi Publications, New Delhi, 2008.
6. S. K. Duggal, *Building Materials*, TMH Publication, 2010.

CV2103: SURVEYING [3 1 0 4]

Principles of surveying, Classification of surveying; Errors and their adjustment; Maps - scale, coordinate system; Chain surveying, compass surveying, Plane table surveying -Radiation and intersection methods; Levelling , trigonometric levelling; theodolite surveying and tachometry surveying; Traversing and triangulation survey, Contouring, using Total Station; curve setting-Horizontal and vertical curves. Photogrammetry - scale, flying height; Remote sensing - basics, platform and sensors, visual image interpretation; Electronic Distance Measurement., Basics of Geographical information system (GIS), Differential Geographical Positioning system (GPS/DGPS), Hydrographic Survey and surveying using Lidar.

References:

1. T. P. Kanetkar, S. V. Kulkarni, *Surveying and Levelling*, Part I and II, Pune Vidyarthi Griha Prakashana – Pune, 1996
2. B. C Punmia, *Surveying,* Vol. I, Lakshmi Publications, New Delhi, 2005.
3. Satheesh Gopi , R. Sathikumar, N. Madhu, *Advanced Surveying: Total Station, GIS and Remote Sensing*

CV2104: STRUCTURAL ANALYSIS [3 1 0 4]

Introduction, Thick Cylinders and Shells, Stresses due to Impact and Suddenly Applied Load, Compound Bars. Mohr's circle of stress and strain. Failure theories, analysis of Plane Truss: Method of joints and section, Shear force and bending moment diagrams for statically determinate beams. Influence line diagram. Determination slope and deflection using Macaulay's method, moment-area method and conjugate beam method. Stability of Columns-Euler's formula, Rankine-Gordon formula. Torsion of circular shaft. Analysis of Arches and Suspension Bridge.

References:

1. R. C. Hibbler, *Structural Analysis*, (8e), Pearsons, 2014
2. S. S. Bhavikatti, *Structural Analysis – II*, (4e), Vikas Publishing House Pvt. Ltd., 2018.
3. E. J. Hearn, *Mechanics of Materials, Vol. I*, (3e), Pergamon Press, 2008.
4. R. K. Rajput, *Strength of Materials*, (7e), S Chand & Co., 2018.
5. P. S. Gahlot, D. Gehlot, *Fundamentals of Structural Mechanics*, (1e), CBS Publishers & Distributors Pvt. Ltd., 2012.
6. R. Subramanian, *Strength of Materials*, (3e), Oxford University Press, 2016.

CV2130: MATERIAL TESTING LABORATORY [0 0 2 1]

Tension, shear and torsion test on mild steel, Compression test on cast iron, timber. Hardness test by Rockwell and Brinell's method. Impact test by Izod and Charpy method. Test on Bricks - Compressive Strength, Absorption, Efflorescence. Tests on Flooring and Roofing Tiles: Wear resistance (Dorry's abrasion Test), Knife Edge Load, Absorption. Determination of specific gravity, Fineness, standard consistency, setting time and soundness of cement. Determination of specific gravity and fineness modulus of fine aggregates. Determination of bulking and clay (or silt) content in sand. Determination of workability of concrete by slump test, compaction factor test and Vee - Bee consistometer method. Determination of compressive, tensile and flexural strength of concrete. Determination of permeability and modulus of elasticity of concrete. Introduction to Non-Destructive test of concrete.

References:

1. A.V.K Suryanarayana, *Testing of Metallic Materials*, Prentice Hall of India, New Delhi, 2007.

2. Technical Teachers, Training Institute, *Laboratory Manual of Strength of Materials*, Oxford University Press, 2010.
3. M.S Shetty, *Concrete Technology*, S. Chand and Co, 2018.
4. Neville, Brooks, *Concrete Technology*, Pearson Education, 2010.
5. G. Singh, *Materials of Construction*, Std. Publishers, 2017.

CV2131: SURVEYING PRACTICE- I [0 0 3 1]

Compass Survey-determine the magnetic bearing of a line, Plane table surveying - Radiation and intersection methods, Solving three point problem by Bessel's solution, Levelling; profile levelling, fly levelling, reciprocal levelling, Theodolite - Measurement of vertical angles and horizontal angles; Method of repetition, Method of reiteration, Distance between inaccessible points, height measurement by theodolite, triangulation survey, tachometric surveying, remote elevation measurements, measurement of area using planimeter and total station. Stereoscopy.

References:

1. T. P. Kanetkar, S. V. Kulkarni, *Surveying and Levelling*, Part I and II, Pune Vidyarthi Griha Prakashana – Pune, 1996
2. B. C Punmia, *Surveying,* Vol. I, Lakshmi Publications, New Delhi, 2005.
3. Satheesh Gopi, R. Sathi kumar, N. Madhu, *Advanced Surveying: Total Station, GIS and Remote Sensing*

FOURTH SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA2207: Engineering Mathematics IV [2 1 0 3]

Numerical solutions of partial differential equations by finite difference methods, five-point formula, Laplace Poisson Equations, Heat equation, Crank Nicolson's method, Wave equation., Introduction to calculus of variations, geodesics, isoperimetric problems, approximate methods, Weighted Residual Approach, Least square method. Application of Finite Difference technique: Statically determinate and indeterminate beams, Buckling of columns. Introduction to Tensor Analysis, Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. Optimization Techniques: Introduction to Linear programming, Formation of Linear Programming problem, solution by graphical method, Simplex method. Two phase simplex method, Transportation problems.

References:

1. S. M. Rajasekaran, *Numerical methods for Science and Engineering*, Wheeler and Co. Pvt. Ltd., Allahabad, 1992.
2. S. S. Sastry, *Introductory methods of Numerical Analysis*, Prentice Hall of India, New Delhi. 1995.

3. A. R. Mitchel, R. Wait, *Finite Element Methods in Partial Differential Equations*, John Wiley, 1997.
4. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.

CV2201: ENGINEERING GEOLOGY [3 0 0 3]

Geology in Civil Engineering. Earth as a planet, internal structure and composition. Identification of rock-forming minerals and Ores, their physical and special properties. Sources of rocks, classification of rocks, rock-cycle, Rock as building material. Rock folds, joints, faults, and unconformity, their recognition and importance in Civil Engineering field investigation. Weathering types, agencies, causes and products of weathering. Origin and development of river systems, geological action of wind and its geomorphic features. Hydrological cycle, distribution of ground water in the earth crust, selection of sites for well locations, geophysical techniques of ground water exploration, artificial recharge of groundwater methods, rain water harvesting. Plate tectonics, earthquake, seismic waves, characteristics of strong ground motions and attenuation. Tsunami and landslides. Geological considerations in selection of sites for Dams, Reservoirs, Tunnels, Bridges and Highways.

References:

1. P. Singh, *Engineering and General Geology*, (8e), New Delhi, India: S. K. Kataria and Sons, 2013.
2. D. V. Reddy, *Engineering Geology for Civil Engineering*, New Delhi, India: Oxford and IBH Publishing Co. Pvt. Ltd., 2012.
3. P. K. Mukherjee, *A Text Book of Geology*, Kolkata, India: World Press, 2005.

CV2202: WATER SUPPLY ENGINEERING [3 1 0 4]

Introduction, Sources of water, Water collection works, Water demand, Population forecasting, Variation in water demand, Factors affecting water demand, Characteristics of water and its analysis, Drinking Water Standards (BIS and WHO), Design capacities for various water supply components. Treatment of Water: Primary, Secondary & tertiary treatment, Design of sedimentation tanks, Coagulation, flocculation & their design criteria including other treatment processes. Filtration theory & design, Disinfection-theory, methods of disinfection, softening, removal of taste, colour & odour, desalination, reverse osmosis, de-fluoridation and removal of other dissolved impurities. Design and layout of distribution systems & transmission, Hydraulic analysis of distribution systems, Pipe appurtenance & Design of plumbing system.

References:

1. S. K. Garg, *Environmental Engg.-I*, Khanna Publishers, New Delhi, 2012.
2. G. S. Birdie, *Water Supply and Sanitary Engineering*, Dhanpath Rai and Sons, New Delhi, 2012.
3. B. C. Punmia, *Water Supply and Sanitary Engg*., Dhanpath Rai and Sons, New Delhi, 2010
4. Modi, Sethi, *Water Supply and Sanitary Engg,* Dhanpath Rai and Sons, New Delhi, 2010.
5. Manual on water supply and treatment CPHEEO, Ministry of Urban development, New Delhi, 1991.

CV2203: ANALYSIS OF INDETERMINATE STRUCTURES [3 1 0 4]

Introduction to indeterminate structures, degrees of freedom per node, static and kinematic indeterminacy. Analysis of beams and frames by slope deflection method, analysis of fixed and continuous beams by theorem of three moments. Analysis of structures using moment distribution methods. Portal frame method, Cantilever method of analysis of frames. Unit load method. Unit load method. Strain energy for gradually applied, suddenly applied and impact loads, Strain energy due to axial loads, bending, shear and torsion; Introduction to matrix method of structural analysis.

References:

1. C. K. Wang, *Indeterminate Structural Analysis*, Indian Ed., McGraw Hill Education, 2017
2. S. Timoshenko, D. H. Young , *Mechanics of Structures*, (3e), Mc Graw Hill Book Co., 2015
3. R. C Hibbler , *Structural Analysis*, (8e), Pearsons, 2014
4. B. C. Punmia, *Strength of Materials and Mechanics of Structures: Vol. I*, (10e), Laxmi Publications (P) Ltd., 2018
5. S. B. Junarkar, H. J. Shah, *Mechanics of Structures Vol.-I*, (3e), Charotar Publishing House, 2013
6. S. P. Gupta, G. S. Pandit, R. Gupta, (3e), Str*uctural Analysis – A Matrix Approach-Volume 2*, McGraw Hill, New Delhi, 2016.

CV2230: Geology Lab [0 0 2 1]

Identification and description of rock-forming minerals with uses and distribution in India. Megascopic study of rocks with their properties and their importance in Civil engineering. Interpretation of horizontal, inclined and vertical rock beds with fold, fault and unconformity from geological maps. Determination of thickness of sub-surface rock-strata on horizontal ground, dip and strike problems, Borehole problems and their uses in dams, tunnels and reservoir site.

References:

1. R. J. Lisle, *Geological Structures and Maps: A Practical Guide*, (3e), Burlington MA, USA, Elsevier, 2004.
2. M. T. M. Reddy, *Engineering Geology Practicals*, New Delhi, India: New Age International Publishers, 2002.
3. W. Gokhale, *Manual of Geological Maps*, New Delhi, India: CBS Publications, 1987

CV2231: FLUID MECHANICS LAB [0 0 2 1]

Calibration of V - Notch, Rectangular notch, Cippoletti Notch, Broad crested weir, curved weir, orifices, mouth pieces, Venturimeter, orifice meter, Venturi flume, standing wave flume, Determination of Friction factor of pipes, Tests on Impact of jet on Vanes, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan Turbine.

References:

1. P. N. Modi, S. M. Seth, *Hydraulics and Fluid Mechanics,* Standard Book House, New Delhi, 2005
2. V. L. Streeter, E. B. Wiley, *Fluid Mechanics*, McGraw Hill Co. New York, 1998.

CV2232: BUILDING PLANNING AND DRAWING PRACTICE [1 0 3 2]

Foundations: Masonry foundations, RCC Footings - Isolated, Combined and Raft footings; Doors and Windows: Wooden and Aluminium doors, PVC and Steel doors such as Collapsible Doors, Wooden windows, Aluminium windows; Designing and Drawing of Residential Buildings/ Studio apartments: Plan, Elevation and Sectional views, Designing and Drawing of Public Buildings: Plan, Elevation and Sectional views of School, Bank, and Health Centre for the given Line Diagram; Introduction to Auto cad: Drafting plan and elevation of single bed room RCC building with flat roof.

References:

1. T. S. Balagopal Pabhu, K.V Paul and C Vijayan, *Building Design of Civil Engg. Drawing,* Spades Publishers, Calicut, 1999.
2. M. G Shah, C. M Kale, & S Patki, Building Drawing: with an integrated approach to built environment. Tata McGraw-Hill Education, 2002.
3. S. C Rangwala, *Elementary and Advanced Building Construction*, 2009.
4. V. B Sikka, *A course in civil engineering drawing*, S.K. Kataria & Sons, Reprint 2013.

FIFTH SEMESTER

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower**.** Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit**.** Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. H. Koontz, *Essentials of Management*, Tata McGraw Hill, New Delhi, 1990.
2. S.P. Robbins, M. Coulter, *Management, Prentice Hall*, New Delhi, 2002.
3. E. S. Buffa, R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987.

4. H. J. Arnold, D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. K. Aswathappa, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. W. Wether, K. Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

CV3101: GEOTECHNICAL ENGINEERING [3 1 0 4]

Introduction: Definition, Historical development of Geotechnical Engineering. Basic Definitions and Relationships: Phase relationships of soil, Basic definitions, Volume relationships, Weight relationships, Relative density. Determination of Index Properties: Particle size distribution by sieve and sedimentation analysis and Consistency limits. Classification of Soils: Gradation of soil, Particle size classification, Unified Soil Classification and Indian Standard Classification. Soil Structure and Clay Mineralogy: Inter-particle forces; Diffused Double Layer, Clay minerals and their properties. Flow through Soils: Darcy's law, Factors affecting and Determination of permeability. Stress in Soil Mass: Total, effective and neutral stress, Effective stress principle, Stress point and Stress path, Calculation of stresses, Soil-water systems-capillarity and Quick sand phenomenon. Seepage Analysis: Seepage forces, One dimensional and two dimensional flow, Laplace equation, Stream and potential functions, Uses of flow net, Determination of phreatic line of an earthen dam and Design of filters. Compaction of Soils: Theory of compaction, Laboratory compaction tests, Factors affecting compaction, Methods of compaction and types of equipment used in field. Shear Strength of Soils: Mohr's circle, Mohr's strength theory, Mohr-Coulomb's strength theory, Determination of shear strength parameters: Direct Shear Test, Unconfined Compression Test, Vane Shear Test, and Tri-axial Shear Test.

References:

1. V. N. S. Murthy, *Soil Mechanics and Foundation Engineering: A Book for Students and Practicing Engineers,* Dhanpat Rai, 1977.
2. K. R. Arora, *Soil Mechanics and Foundation Engineering*, Standard Publishers and Distributors, New Delhi, 2005
3. Alam Singh, *Soil Engineering in Theory and practice*, CBS Publishers and Distributors, Delhi, 2006
4. K. Terzaghi, R. B. Peck, Messi Gholamreza, *Soil Mechanics in Engineering Practice*, Wiley India (P) Ltd., New Delhi, (3e), 2013
5. T. W Lambe, R. V. Whitman, *Soil Mechanics*, John Wiley and Sons, Inc., 1969

CV3102: HIGHWAY ENGINEERING [3 1 0 4]

Highway classifications, design of road length as per 20 year plans, Geometric design. Sight distance-stopping and overtaking, horizontal curve, extra widening. Super elevation, transition curve, vertical curves-summit and valley Curves, design problems, design of cross drainage structures. Pavement materials, design of bituminous mixes. Design of flexible pavements, rigid pavement design, stresses in rigid pavement, joints and failures of rigid pavement. Highway economics and finance: Methods of Economic Analysis-benefit cost ratio, net present value method. Transport planning. Introduction to pavement overlay. Traffic engineering: Traffic engineering, vehicular and road user characteristics. Traffic studies, relation between speed, travel time and traffic volume. Traffic density and passenger car units, traffic signs and traffic signals, design of traffic signals. Accident studies – overview, objectives, causes, accident analysis and road safety

References:

1. S. K. Khanna, C.E.G. Justo, *Highway Engineering*, Nemchand and Bros., Roorkee, 2013
2. L. R. Kadiyali, *Traffic Engineering and Transportation Planning*, Khanna Publisher, New Delhi 2002
3. C. S. Papacoastas, P. D. Prevedouros, *Transportation Engineering and Planning,* Prentice Hall, 2002.
4. Jotin Khisty, B. Kent Lal, *Introduction to Transportation Engineering*, Prentice Hall, edition 2002

CV3103: DESIGN OF REINFORCED CONCRETE STRUCTURES [3 1 0 4]

Introduction: Overview and scope of the subject. Limit state method design and analysis of singly reinforced, doubly reinforced, and flanged beams. Analysis and design of flexural members in shear. Limit state Design of one way and two way slabs. Design of columns. Limit state design of footings. Determination of short term, long term deflections of R.C beams & Crack width; Use of SP16 handbook.

References:

1. J. N Bandyopadhyay, *Design of Concrete Structures*, Prentice Hall of India, New Delhi.
2. S. U. Pillai, D. Menon, *Reinforced Concrete Design*, Tata McGraw Hill, 2017.

3. N. Krishna Raju, *Design of Reinforced Structures IS 456:2000,* 4e, CBS Pub. and Distributors Ltd., 2016
4. P. C. Verghese, *Limit State Design of Reinforced Concrete*, Prentice Hall of India, New Delhi, 2009.
5. H. J. Shah, *Reinforced Concrete, Vol. I*, Charotar Publishing house, Anand, 2016.
6. M. L. Gambhir, *Design of Reinforced Concrete Structures*, PHI Learning, 2012.

CV3104: WASTE WATER MANAGEMENT [3 1 0 4]

Overview and general terms. Characteristics of sewage, standards of disposal into natural waters and on land, Indian standards. Collection of sewage, components of sewerage systems and layout, quantity of sanitary sewage and variations. Hydraulic design of sewers. Treatment of sewage: Various units and their purposes, layout of different units, preliminary treatment, screening and grit removal units, oil and grease removal, primary treatment, secondary treatment, activated sludge process, Membrane bioreactor technology, Sequencing batch reactor, trickling filter, sludge digestion and drying beds, stabilization pond, septic tank, soakage systems, recent trends in sewage treatment. Advanced wastewater treatment - nutrient removal. Waste water disposal and reuse: Disposal of sewage by dilution, self- purification of streams, sewage disposal by irrigation, sewage farming and waste water reuse. Plumbing of building and layout of house drainage

References:

1. C. Sawyer, P, McCarty and G. Parkin, *Chemistry for Environmental Engineering and Science*, 5/e, McGraw Hill, New Delhi, 2003.
2. IS Standards 2490 - 1974, 3360 – 1974, 3307 – 1974, Indian Standard Institution, Manak Bhavan, New Delhi.
3. *Manual on sewage and sewage treatment CPHEO*, Ministry of Urban development, New Delhi.
4. Metcalf, Eddy, *Waste Water Engg, Treatment and Reuse*, Tata McGraw Hill, New Delhi, 1974.
5. *Standard Methods*, APHEA, American Public Health Association, 1015 Fifteenth Street, NW Washington DC.
6. S. K. Garg, *Environmental Engg- II*, Volume – II, Khanna Publishers, New Delhi, 2015.
7. G. S. Birdie, *Water Supply and Sanitary Engineering*, Dhanpat Rai and Sons, New Delhi, 2012

CV3130: GEOTECHNICAL ENGINEERING LABORATORY [0 0 2 1]

Determination of water content, specific gravity, particle size distribution of coarse and fine grained soils; Atterberg's limits of soil; Determination of dry density of natural soil; Determination of relative density of coarse grained soils; Determination of compaction characteristics of soils using standard Proctor and modified Proctor method; Determination of California Bearing Ratio (CBR) of soil in dry and wet condition; Determination of Unconfined Compressive Strength (UCS) of soil; Determination of shear strength parameters of soil using direct shear test; Determination of shear strength of clay by using Vane shear test; Determination of the coefficient of permeability of soils by constant and falling head method; Determination of shear strength parameters of soils using Triaxial tests; Determination of compressibility characteristics of soil by using one dimensional oedometer test.

References:

1. Relevant IS codes.
2. J. E. Bowles, *Engineering properties of soil and their measurement*, (2e), McGraw – Hill Book Company, New York, 1986
3. T. W. Lambe, *Soil testing for Engineers*, John Wiley and Sons, INC, 1951.
4. Liu Cheng, B. Evett Jack, *Soil properties, Testing, Measurement and Evaluation*, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1987
5. K. R. Arora, *Soil Mechanics and Foundation Engineering*, Standard Publishers and Distributors, New Delhi, 2005

CV3131: ENVIRONMENTAL ENGINEERING LABORATORY [0 0 2 1]

Determination of solids - total solids, suspended solids, dissolved solids, volatile solids, fixed solids, settle able solids. Determination of turbidity in water sample and Jar test for determination of optimum coagulant dose. Determination of pH, alkalinity, acidity and chloride in the given water sample. Determination of Calcium, Magnesium and total hardness in the given water sample. Determination of dissolved oxygen in the given water sample. Residual chlorine and chlorine demand in the given water sample. Determination of percentage available chlorine in Bleaching powder. Determination of Fluorides in the given water sample. Determination of Biochemical Oxygen Demand in the given water sample. Determination of Chemical Oxygen. Total count test and determination of most probable number in the given water sample. Determination of PM10 and PM2.5, sulphur dioxide and oxides

of nitrogen from ambient air. Measurement of noise level. Demonstration of pipes, joints and fixtures, sanitary fittings.

References:

1. Standard Methods for the Examination of Water and Waste Water - ALPHA - AWWA – WPCF.
2. C. McCarty, P. Sawyer, G. Parkin, "*Chemistry for Environmental Engineering",* McGraw Hill, New York. 1994.
3. IS - 3025 - 1964 - *Methods of Sampling and Test (Physical and Chemical) for Water Used in Industry*, IIT New Delhi.
4. Drinking water Standards IS - 10500-1991.

SIXTH SEMESTER

CV3201: APPLIED GEOTECHNICAL ENGINEERING [3 1 0 4]

Stress Distribution in Soils: Elastic theories of stress distributions in soils, Pressure distribution diagram, vertical pressure under uniformly loaded circular and rectangular area, Newmark's influence chart; Contact Pressure. Consolidation of soils: Terzaghi's one dimension consolidation theory, Normally, under and over consolidated soils, Laboratory one-dimensional consolidation test, Compressibility characteristics, Determination of void ratio, Coefficient of volume change, Coefficient of consolidation and settlement, Estimation of pre-consolidation pressure, Time factor, Degree of consolidation, and Factors influencing compressibility behaviours of soils. Stability of Slopes: Classifications of slopes, Mode and causes of slope failures, Stability analysis of infinite slopes, Stability analysis of finite slopes by Swedish circle method, Stability analysis by Taylor's stability number, Bishop's method of stability analysis. Earth Pressure: Theories of earth pressure, Culman's graphical methods for earth pressure for vertical and inclined back retaining walls horizontal and inclined cohesionless back fill. Shallow Foundations: Bearing capacity and its types, Types of foundations, Terzaghi and Meyerhoff's theory for bearing capacity, Skempton's method for cohesive soil, Effect of eccentricity and water table on bearing capacity. Deep Foundations: Types of piles, Load carrying capacity of piles, Static and dynamic formulae; Group behaviour of piles; Negative skin friction and Pile testing. Site Investigations: Methods of explorations; Plate load and Penetration tests for determining bearing capacity, Introduction to geophysical methods of investigations.

References:

1. V. N. S. Murthy, *Soil Mechanics and Foundation Engineering: A Book for Students and Practicing Engineers*, Dhanpat Rai, 2015
2. K. R., Arora*, Soil Mechanics and Foundation Engineering*, Standard Publishers and Distributors, New Delhi, 2009
3. Alam Singh, *Soil Engineering in Theory and practice*, CBS Publishers and Distributors, Delhi, 2009
4. K. Terzaghi, R. B. Peck, Gholamreza Messi, *Soil Mechanics in Engineering Practice*, Wiley India (P) Ltd., New Delhi, (3e), 2013
5. J. E. Bowles, *Foundation Analysis and Design*, McGraw Hill, New York, 2017

CV3202: DESIGN OF STEEL STRUCTURES [3 1 0 4]

Scope and use of structural steel. Structural fasteners: Bolted and welded connections. Design of Tension members. Sections with welded and bolted connections, lug angle. Design of compression member. Design of column splices. Design of column base. Design of beams- laterally supported and laterally unsupported compression flange. Plastic analysis. Design of Industrial buildings.

References:

1. N. Subramanian, *Design of Steel Structures*, Oxford University press, New Delhi, 2016.
2. S.K. Duggal, *Limit State Method of Design of Steel Structures*, Tata McGraw-Hill, New Delhi, 2017.
3. M.R. Shiyekar, *Limit State Design in Structural Steel*, PHI Learning Pvt. Ltd., 2017.
4. K.M. Ghosh, *Analysis and Design: Practice of Steel Structures*, PHI Learning Pvt. Ltd., 2014.

CV3203: RAILWAYS AND AIRPORT ENGINEERING [3 1 0 4]

Introduction, gauges, resistance to traction and stresses in track. Permanent way: Types and requirements of rails, sleepers, ballasts, introduction to rail fastenings, tests and defects of rails. Geometric design: Right of way, Super elevation, curves, points and crossing, design of turn out, diamond and scissor crossing. Track Layout: Track layout,

Introduction to signalling and interlocking Railway equipment (triangle and turntable), Introduction to Accident studies, High speed Railways. Airport engineering: Introduction, Technical terms relating to airways and airport, aircraft characteristics, site selection. Airport obstruction and runway design: Layout, obstructions and zoning laws, runway orientation and geometric design of runway. Taxi way design and navigational and landing aids: Exit taxiway, Apron, Drainage, Lighting system, Visual aids, and Air traffic control aids.

References:

1. S. Chandra, M. M. Agarwal, *Railway Engineering*, (4e), Oxford University Press, 2014
2. S. C. Rangwala, *Airport Engineering*, (7e), Charotar Publishing House, 2018
3. S. C. Saxena, S. P. Arora, *A Text Book of Railway Engineering*, (4e), Dhanpatrai publication 2004
4. S. K. Khaana, M. G. Arora, *Airport Planning and Design*, (4e), Nem chand & Bros, 2000
5. H. Robert, Mc. K. Francis, *Planning and Design of Airport*, (5e), Mcgraw hill, 2010.

CV3230: COMPUTER AIDED DESIGN LAB [0 0 2 1]

Introduction to STAAD Pro. Software package- it is widely used for structural analysis and design of civil engineering structures. Modeling, analysis and design of continuous beams, plane trusses, plane frames, space frames, G+4 building using STAAD Pro.

References:

1. "*STAAD.Pro V8i (SELECTseries 4) Technical Reference Manua*l," no. November, 2012.
2. M. N. S. Prakash and G. S. Suresh, *Reference book on computer aided design laboratory : civil engineering : application of C-Graphics and Excel included*. Laxmi Pub, 2006.
3. D. Rajendran, *Analysis & Design of a Multistorey Building using STAAD.Pro & E-TABS (with Manual Calculation),* First Edition. Designtech Publishers, 2016.

SEVENTH SEMESTER

CV4170 MINOR PROJECT [0 0 3 1]

In-house student projects will be offered in various domains pertaining to Civil Engineering

CV4171 INDUSTRIAL TRAINING [0 0 2 1]

Students will undertake industrial / site training in the domain pertaining to Civil Engineering for a period of 4-6 weeks during the summer break after 6th Semester

CV4172 SURVEY CAMP [0 0 3 1]

Group field survey exercise will be undertaken at a designated location to gain hands-on experience in different types of surveys in Civil Engineering.

EIGHTH SEMESTER

CV4270 MAJOR PROJECT [0 0 0 12]

Students will undertake a project in the domains pertaining to Civil Engineering for a minimum period of 16 weeks.

PROGRAM ELECTIVES- I & II

CV 3240: FINITE ELEMENT ANALYSIS [3 0 0 3]

Introduction to finite element analysis: Basic concept, theory of elasticity - constitutive relationships - plane stress and plane strain. Concept of an element, types of elements, displacement models - compatibility and convergence requirements, displacement models by generalised coordinates, Lagrangian polynomials and Hermitian polynomials. Variational method of formulation, Application of Finite element method to pin jointed and rigid jointed structures, Application to plane stress and plane strain problems.

References:

1. K. J. Bathe, *Numerical methods in Finite Element Analysis*, Prentice-Hall, 1976.
2. D. Robert, C. David, S. Malkus, *Concepts and applications of Finite Element Analysis,* 1987.

3. O. C. Zienkiewicz, R. L. Taylor, J. Z. Zhu, *The Finite Element Method: Its Basis and Fundamentals*, Butterworth-Heinemann, 2005.
4. J. Chaskalovic, *Finite Elements Methods for Engineering Sciences*, Springer Verlag, 2008

CV3241: ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES [3 0 0 3]

Introduction, Design of a Continuous beams. Design of single span and continuous deep beams with and without opening, Design example of a typical Silo, Design of bunker. Design of retaining walls, Design of water tanks (elevated and underground). Introduction to types of trusses and a design example of a fink type Truss. Design of the curved beam. Various types of stresses in chimney and design of concrete chimney

References:

1. J. N. Bandyopadhyay, *Design of Concrete Structures*, Prentice Hall of India, New Delhi, 2008.
2. S. S Bhavikatti, *Advanced RCC Design,* (Vol II), New Age International Publishers, 2016.
3. P. C. Verghese, *Advanced Reinforced Concrete*, Prentice Hall India, New Delhi, 2010.
4. N. Krishna Raju, *Design of Reinforced Structures*, CBS Publishers & Distributors, 2016.
5. P. C. Verghese, *Limit State Design of Reinforced Concrete*, Prentice Hall of India, New Delhi, 2009.

CV 3244: REMOTE SENSING AND GIS APPLICATIONS [3 1 0 4]

Basics of Remote Sensing, Characteristic of remote sensing systems, Platforms-Satellites. Indian remote sensing satellites, Sensors, Satellite Retrievals. Elements of image interpretation, Concepts of Digital Image Processing. Geographical Information System (GIS), Elements of GIS, GIS Analysis: Vector and raster data model, mapping concept, map overlay, overlay operation, data storage and database management. Remote sensing and GIS applications in Energy and Environmental Engineering.

References:

1. B. Bhatta, *Remote Sensing and GIS*, (2e), Oxford University Press, 2011.
2. K. C. Clarke, B. O. Parks, M. P. Crane, *Geographic Information Systems and Environmental Modeling*, Prentice-Hall of India, 2005.
3. P.A. Burrough, *Principle of Geographical Information Systems for Land Resources Assessment*, Clarendon Press, Oxford, 2000.
4. A. N. Patel, Surendra Singh, *Remote Sensing Principles and Applications*, Jodhpur, India, Scientific Publisher, 1999.
5. T. M. Lillesand, R. W. Kiefer, *Remote Sensing and Image Interpretation*, New York, USA, John Wiley & Sons, 1999

CV 3245: HYDRAULICS AND HYDRAULIC MACHINES [3 0 0 3]

Review of Fundamentals of Open Channel Flow Gradually varied flow, rapidly varied flow: Introduction to spatially varied flows, Boundary layer theory, Flow through immersed bodies, Impulse Momentum Principle and Its Applications, hydro power plants, Hydraulic turbines, Hydraulic Pumps: Reciprocating Pumps.

References:

1. Chow Ven Te, *Open Channel Flow*, McGraw Hill Company Ltd., New York, 1985
2. K. Subramanya, *Flow in Open Channels*, Tata McGraw Hill Publishing Company, New-Delhi, 2005
3. P. N. Modi, S. M. Seth, *Hydraulics and Fluid Mechanics*, Standard Book House, New Delhi, 2005
4. R. K. Bansal, *Fluid Mechanics and Hydraulic Machines*, Laxmi Publishers, New Delhi. 2010

CV3246: SANITATION TECHNOLOGY [3 0 0 3]

Onsite sanitation treatment technologies :- Carbon, nitrogen and phosphorus removal & recovery; sludge treatment, Case Studies in Sanitation, Faecal sludge treatment technologies, Innovation processes, Onsite Sanitation, collection and transport, Urban Drainage and Sewerage.

References:

1. L. Strand, D. Brdjanovic, *Faecal Sludge Management: Systems Approach for Implementation and Operation* [Book]. - EAWAG – Swiss Federal Institute of Aquatic Science and Technology, Switzerland: IWA Publishing, 2014.
2. M. Henze, C.M. van Mark, D. Brdjanovic, *Biological Wastewater Treatment* [Book] - Delft: IWA Publishing, 2008.

CV 3247: WATER RESOURCE ENGINEERING [3 0 0 3]

Introduction: Scope and need of the subject, Hydrology, rainfall and runoff process, infiltration. Flood studies and hydrographs, River Engineering, Methods of design of stable channels, Energy dissipation, Reservoir Planning, Design of Diversion and Storage works, River training works, Dams and basic principles of design. GIS application in Water Resources Engineering.

References:

1. Viessman, Knapp, *Introduction to Hydrology*, Harper and Row Publishers, Singapore. 2015
2. H. M. Raghunath, *Hydrology*, Wiley Eastern publications, Delhi. 2015
3. S.K. Garg, *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers, Delhi. 2012
4. P. N. Modi, *Irrigation, Water resource and Water Power*, Standard book house publications, Delhi. 2014
5. H. J. Shah, *Reinforced Concrete*, Vol. I, Charotar Publishing house, Anand, 2016.
6. M. L. Gambhir, *Design of Reinforced Concrete Structures*, PHI Learning, 2012.

CV3242: ENVIRONMENTAL IMPACT ASSESSMENT [3 0 0 3]

Definitions and concepts, rationale and historical development of EIA, EIA process in India and other countries, EIA laws and regulations, The Environmental Protection Act, The Water Prevention Act, The Air (Prevention & Control of Pollution Act.), Wild life Act etc. EIA Methodologies: introduction, Criteria for the selection of EIA Methodology, EIA methods, Adhoc methods, Matrix methods, Network method, Environmental Media Quality Index method, Overlay methods and Cost/benefit Analysis. Planning and Management of impact studies; Impact identification: Matrices, Networks, and Checklists. Description of affected environment, Indices and indicators for describing affected environment; Prediction and Assessment of Impacts: Air, Surface water, Soil and groundwater, Noise, Biological, Cultural and socio-economic environment, Decision methods for evaluation of alternatives, Public participation in environmental decision making; Documentation and environmental monitoring: Case studies, Environmental audit, Meaning, Importance.

References:

1. L. W. Canter, *Environmental Impact Assessment*, (2e), McGraw-Hill, 1997
2. Y. Anjaneyulu, *Environmental Impact Assessment Methodologies*, by, B.S. Publication, Sultan Bazar, Hyderabad, 2006.
3. P. Judith, G. Eduljee, *Environmental Impact Assessment for Waste Treatment and Disposal Facilities*, John Wiley & Sons, 1994
4. G. Burke, B. R. Singh, L. Theodore. *Handbook of Environmental Management and Technology*, (2e), John Wiley & Sons, 2000.

CV3243 AIR POLLUTION AND CONTROL [0 0 3 3]

Air Pollution: Definition of Air Pollution, Global effects of air pollution, Air Pollution Episode, Sources and types of air pollutants, Effect of air pollutants on human beings, plants, animals and economic aspects. Sampling of sir pollution: Air pollution control acts, ambient air quality standards, sampling and measurement of particular and gaseous pollutants. Meteorology: Environmental factors affecting meteorology, elemental properties of the atmosphere. Influence of meteorological phenomena on air quality. Plume dispersion phenomenon, Air modelling, maximum mixing depth, Design of stack. Controlling of air pollution: Controls – particulate pollutants, Source control. Controlling equipment, settling chambers, ESP, Particulate scrubbers and filters. Gaseous pollutants – absorption, adsorption devices, combustion and condensation devices.

References:

1. H. V. N. Rao, M. N. Rao, *Air Pollution*, Tata McGraw Hill, New Delhi, 2001.
2. Air Pollution, *Sampling and Analysis*, APHA, 1989.
3. C. S. Rao, *Environmental Pollution Control*, Wiley Eastern Ltd. Delhi, 1995.
4. N. De. Nevers, *Air Pollution Control Engineering*, McGraw Hill, Inc. New York, 1995.
5. S.P. Mahajan, *Pollution Control in Process Industries*, TMH Publishing Co., New Delhi, 2000.

PROGRAM ELECTIVES – III, IV, V, VI & VII

CV4140: EARTHQUAKE RESISTANT DESIGN OF STRUCTURES [2 1 0 3]

Introduction: Plate tectonics, Elastic rebound theory of earthquake, Seismic zoning map of India, Seismic waves, Seismograms, Earthquake magnitude and intensity. Introduction to theory of vibrations: Free vibration of single degree un-damped and damped systems, Forced vibration (Harmonic Loading) of single degree un-damped and damped systems; Resonance. Introduction to MDOF system, (Stodola's method) Primary and secondary effects of earthquake; Calculations of modes and mode shapes. Effect of structural irregularities on the performance of RC buildings during Earthquakes: Vertical irregularities, Plan configuration problems; Numerical Method of analysis-Time stepping method, Central Difference Method, Newmark's method. Equivalent static method (IS 1893); Seismic Coefficient method, Introduction to Pushover analysis; Ductile detailing of RC frames as per IS 13920 (1993).

References:

1. P. Agarwal, M. Shrikhande, *Earthquake Resistant Design of Structures*, Prentice-Hall of India Private Limited, New Delhi. 2006.
2. S. K. Duggal, *Earthquake-Resistant Design of Structures*. Oxford University Press, 2013.
3. A. K. Chopra, Dynamics *of structures: theory and applications to earthquake engineering* (Vol. 2). Englewood Cliffs, NJ: Prentice Hall, 2013.
4. Mario Paz, William Leigh. *Structural dynamics*. New York: Van Nostrand Reinhold, 1985.
5. C.V.R Murty, *Earthquake Tips- Learning Earthquake Design and Construction*, National Information Centre of Earthquake Engineering, IIT Kanpur 2005.
6. IS: 1893 (Part 1) - 2016, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
7. IS: 13920 - 1993, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces- Code of Practice, Bureau of Indian Standards, New Delhi.

CV4141: DESIGN OF PRESTRESSED CONCRETE STRUCTURES [2 1 0 3]

Introduction & Basic principles of pre-stressing: Load balancing concept, Stress concept, Centre of thrust, Pre-tensioning and Post tensioning systems, Tensioning methods and end anchorages. Analysis of sections for flexure: Stresses in concrete due to pre-stress and loads, Stresses in steel due to loads. Losses of pre-stress, Short term and long term deflections of un-cracked members, I.S. code provisions; Limit state of collapse and serviceability: I.S. Code recommendations- Ultimate flexural and shear resistance of sections; shear reinforcement Limit state of serviceability: Control of deflection and cracking, Transmission length, Bond stress, Anchorage stresses, I.S. code provisions for the design of end block reinforcements. Design of pre-tensioned and post-tensioned symmetrical and unsymmetrical sections: Permissible stresses, Design of pre-stressing force and eccentricity, Limiting zone of pre-stressing force and eccentricity, Cable profile - Magnels chart.

References:

1. N. K. Raju, *Pre-stressed Concrete*, Fourth Edition, Tata McGraw Hill, New Delhi, 2007.
2. P. Dayaratnam, *Pre-stressed Concrete Structures*, Oxford and IBH Publications, New Delhi, 1996.
3. G. S. Pandit, S. P. Gupta, *Pre-stressed Concrete*, CBS Publishers & Distributors Pvt. Ltd., 2009.
4. IS: 1343-1980, Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi, 1981.
5. SP16:1980, Design Aids for Reinforced Concrete, Bureau of Indian Standards, New Delhi, 1992.

CV4142 SOLID AND HAZARDOUS WASTE MANAGEMENT [2 0 1 3]

Classification of solid wastes and its management system, Regulatory aspects of SWM, Waste generation and composition, Waste stream assessment, Waste Characteristics, Environmental and health effects, Storage and collection, Transfer stations, Waste collection system design, Waste disposal options and selection criteria, Waste Processing techniques-purpose of processing, Mechanical volume and size reduction, Component separation, Drying and dewatering, Source reduction, Product recovery and recycling, Recovery of biological conversion products, Sanitary landfill, Landfill liners, Leachate and landfill gas management, Composting, Biogasification, Incineration, Introduction to Hazardous Waste Management (HWM), Identification and classification, International regulatory framework for HWM, Storage, Transportation and Treatment of hazardous waste, Concept of Integrated waste management.

References:

1. A.D. Bhides and B.B. Sudaresan, *Solid Waste Management for Developing Countries*, Indian National Scientific Documentation Centre, 1983.
2. T.V. Ramachandra, *Management of Municipal Solid Waste*, The Energy and Resources Institute (TERI), 2009.
3. G. Tchobanoglous,H. Theisen, S.A. Vigil, *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw- Hill Publication, 1993.
4. C. A. Wentz; *Hazardous Waste Management*, McGraw-Hill Publication, 1995.

CV4143 INDUSTRIAL WASTEWATER TREATMENT [2 0 1 3]

Wastewater treatment quality criteria and effluent standards, characteristics, Preliminary, Primary, Biological treatment process and Advanced treatment processes: Adsorption, Chemical oxidation, Ozonation, Photo catalysts, wet air oxidation, evaporation, Ion exchange, Membrane Technologies, Concept of zero liquid discharge, Wastewater disposal in receiving bodies, Case studies: Effluent treatment plants in Textile, Tanneries, Pulp and paper, Sugar and distilleries and Pharmaceutical industries. Lab may include tests for water quality, pH, turbidity, COD, BOD, total solids, suspended solids, dissolved solids, fluoride, residual chlorine, determination of particulate matter in air, high volume sampler, determination of SO2, Determination of SPM, PM_{10} and $PM_{2.5}$ using a High volume sampler

References:

1. Metcaff, Eddy, *Wastewater Engineering: Treatment and Reuse* (5e), McGraw Hill, 2007.
2. J. D. Edwards, *Industrial Waste Water Treatment: A Guide Book* (1e), CRC Press, 1995.
3. A.D. Patwardhan, *Industrial Waste Water Treatment*, Prentice Hall India, 2008.
4. V. V. Ranade, V. M. Bhandari, *Industrial Wastewater Treatment, Recycling and Reuse* (2e), Prentice Hall India, 2017.
5. R. L. Droste, *Theory and Practice of Water and Wastewater Treatment*, John Wiley & Sons, 2005

CV4144: REPAIR AND REHABILITATION OF STRUCTURES [2 1 0 3]

Introduction and terminology: Introduction, Maintenance, rehabilitation, repair, retrofit and strengthening, need for rehabilitation of structures. Distress and Deterioration in structures: Types of distress and deterioration in concrete structures, causes and effects. Assessment Techniques: Visual inspection, Non Destructive and Semi Destructive Testing for assessing strength, voids, flaws, density, moisture content, cover depth, rebar corrosion and bond strength. Repair Methods and materials: material selection, compatibility between repair material and existing concrete, repair techniques for different types of structural elements and structures. Seismic evaluation and strengthening of existing reinforced concrete buildings. Retrofitting and strengthening of structural elements and structures. Case studies on distress, repair and rehabilitation of structures.

References:

1. D. C. Allen, H. Roper, *Concrete Structures, Materials, Maintenance and Repair*, Longman Scientific and Technical UK, 1991.
2. R. T. Allen, S. C. Edwards, *Repair of Concrete Structures*, Blakie and Sons, UK, 1987.
3. P. I. Modi, C. N. Patel, *Repair and Rehabilitation of Concrete Structures*, PHI Learning, India, 2015.
4. A. R. Santha kumar, *Training Course notes on Damage Assessment and repair in Low Cost Housing*, "RHDC-NBO" Anna University, July 1992.
5. P. K. Guha, *Maintenance, and Repairs of Buildings*, New Central Book Agency (P) Ltd, 2011.
6. IS 15988: 2013, Seismic evaluation and strengthening of existing reinforced concrete building – Guidelines.

CV4145: ADVANCED CONCRETE TECHNOLOGY [2 1 0 3]

Chemistry of cement: Bogue's compounds, stages of hydration and hardening of cement, heat of hydration, gel-space ratio and its significance. Fresh Concrete: Definition, Grade, water cement ratio and its role, Properties of fresh concrete, Factors affecting workability, Influence of aggregate properties on workability, methods of workability determination. Concrete Admixtures: Chemical and mineral admixtures, their types and uses, water reducers, accelerator, retarders, water-proofing plasticizers, super plasticizers, air-entraining agents. Hardened Concrete: Properties of hardened concrete, strength, permeability, creep, shrinkage, and factors influencing properties of concrete in hardened state. Durability of Concrete: Definition, parameters effecting durability. Deteriorating mechanisms, alkali aggregate reaction, freeze and thaw, carbonation, chloride attack, sulphate attack, corrosion of

steel reinforcement. Modern Concrete Technology: Ready Mix Concrete, Pumpable concrete, High Strength and High performance Concrete, Self-Compacting Concrete, Light Weight Concrete, Recycled Aggregate Concrete, Geopolymer, Fiber Reinforced Concrete, waste utilization in concrete.

References:

1. A. M. Neville, *Properties of Concrete*, Pearson Education India; 5 edition, 2012
2. M. S. Shetty , *Concrete Technology*, S. Chand & Company, 2015
3. A. R. Santha Kumar, *Concrete Technology*, Oxford University Press, 2006.
4. R. Siddique, *Waste Materials and By-Products in Concrete*, Springer.

CV4146: ESTIMATION COSTING AND VALUATION [2 1 0 3]

Estimation: Introduction, definition, Types of estimate, approximate estimate, Centre line method, long wall-short wall method, units of measurement: IS 1200, work charged establishment, Plinth area, Carpet area. Estimate of building, doors and windows, RCC work, different types of roof, Measurement of earthwork by cross-sections, spot levels, contours. Mass diagram and its characteristics: Specification-definition, types, principles. Detailed specification for different components of the buildings. Rate Analysis: purpose, factors effecting, overhead charges, turn out of work, rate analysis for different items of building; Contract-Functioning and organization of PWD; Tender and its notification, EMD and security deposit; Contracts: Types of contract, termination of contract, work slip qualification of contractor, responsibilities of engineer, owner, and contractor; Valuation: Purpose of valuation, scrap value, salvage value, market value, Factors which affect the value, sinking fund, year's purchase, depreciation.

References:

1. B. N. Dutta, *Estimating and Costing in Civil Engineering*, UBS Publishers' Distributors Ltd. Sixteenth reprint, 2000.
2. M. Chakraborti, *Estimating, Costing, Specification & Valuation in Civil Engineering*, Published by the Author, Sixteenth edition, 2003.

CV4147: CONTRACT MANAGEMENT AND ARBITRATION [2 1 0 3]

Introduction to contracts: Types of contracts. Tendering and contractual procedures - Technical sanction, Notice inviting tender. Multiple bids, Evaluation of bids, Pre-requisites in an agreement, various types of bonds, etc. Contract administration; Duties and responsibilities of parties; important site documents Claims and disputes, Dispute resolution techniques, International contracts: International Competitive Bidding, Domestic Preference, FIDIC Conditions, Currency of Bid and Payment, Escalation in Foreign Currency, Financing of projects, Applicable Law and Settlement of Disputes. International Arbitration.

References:

1. B. S. Patil, *Civil Engineering Contracts and Estimates*, University Press, 2009.
2. G. Betty John, *Engineering Contracts*, McGraw Hills 19
3. B. J. Vasavada, *Engineering Contracts and Arbitration*, Jubilee Publications, 2nd Edition, 1996.

CV4148: CONSTRUCTION PROJECT MANAGEMENT [2 1 0 3]

Introduction to Construction Management- Classification of construction works, various stages in the Construction of a Project, construction team, Work Breakdown Structure for Building and infrastructural projects. Project Planning and scheduling - Objectives and stages of planning and Scheduling, types of schedules. Network Analysis- network rules, preparation, and numbering. CPM analysis- Calculation of activity times, float, critical path. Pert Analysis– Time estimates, slack, critical path, probability of completion time of project. Project Costs – Direct & Indirect Costs, Optimum Duration and Cost, Cost Slopes. Management of Construction equipment- Classification of construction equipment, earthmoving, hoisting (derrik, hydraulic, tower crane) hauling, piling, compaction, and concreting equipment, factor affecting selection of construction equipment, Owning and Operating cost of equipment.

References:

1. B. Sengupta, M Guha, *Construction Management and Planning,* McGraw Hill, 2016 Reprint
2. B. C. Punamia, K K Khandelwal, *Project Planning and Control with PERT and CPM*, Laxmi Publications Pvt Ltd, 2014 Reprint
3. S. C. Sharma, *Construction Equipment and Management*, Khanna Book Publishing Company, 2016
4. K. K. Chitkara, *Construction Project Management – Planning, Scheduling and Controlling*, Tata McGraw Hill, 1999 Reprint

5. Peurifoy, Schexnayder, Shapira, *Construction Planning, Equipment and Methods*, Tata McGraw Hill, 2015 Reprint.

CV4149: GROUND IMPROVEMENT TECHNIQUES [2 1 0 2]

Introduction: Need for ground improvement techniques, Different types of problematic soils, Classification of ground modification techniques and Emerging trends in ground improvement. Mechanical Modification: Requirements of shallow and deep compaction, Shallow, deep and dynamic compaction, Properties of compacted soil and compaction control, Vibro compaction and Vibro replacement-stone columns. Hydraulic Modification: Objectives and techniques, Dewatering methods, Design of dewatering systems and preloading methods. Vertical drains: Sand drains and prefabricated drains. Physical and Chemical Modification: Modification by admixtures, Cement, Lime, Fly ash, Industrial wastes etc., Stabilization of soil with lime columns and cement columns, Construction techniques and applications. Thermal Modification: Thermal properties of soils, Heat treatment of soils and Ground freezing. Grouting: Principles, Types of grouting, Different varieties of grout materials, Design considerations and parameters, Construction, Quality control and assurance. Modification by inclusions: Geo-synthetics: Types, Civil engineering applications of geo-synthetics. Soil Nailing and Soil Anchoring: Applications, Principles, Design consideration and parameters, Construction procedure, quality control and assurance.

References:

1. M. R. Hausmann, *Engineering principles of ground modification*, McGraw-Hill, 1990
2. J. Han, *Principles and practice of ground improvement*, John Wiley & Sons, 2015
3. Purushottam Raj , *Ground Improvement Techniques*, Tata Mc Graw Hills, Delhi
4. Mitchell, James Kenneth, Kenichi Soga, *Fundamentals of soil behaviour*, (3e), Wiley Publication, 2005.
5. Sivakumar Babu G. L., *An introduction to Soil Reinforcement and Geosynthetic*, Universities Press, Hyderabad, 2009.

CV4150 ROCK MECHANICS AND UNDERGROUND EXCAVATION [2 1 0 3]

Properties of Rock Materials: Rock materials; Physical properties; Strength behaviour; Stress-strain relationships; Factors influencing strength. Rock Mass Behaviour: Failure criteria; Coulomb, Mohr's, Griffiths and Modified Griffiths criteria; Post failure behaviour; Shear strength of jointed rock, roughness, peak and residual strengths; Strength criteria for rock mass. Classification of Rock Mass and Applications: Intact and rock mass classifications: Terzaghi, RQD, RSR and RMR classifications; CSIR classification of jointed rocks; NGI tunnelling quality index. Underground Excavations: Types and classification of underground openings; Methods of underground excavation; Factors affecting design; Design methodology. Stresses and Deformations around Underground Excavations: Component of stress, state of stresses: two dimensional and in situ; Stresses and deformation around underground excavations: single and multiple, circular and other shapes. Support Systems for Underground Excavations: Types of support system: Rockbolts, Shotcrete and mesh; Design based on analytical and empirical methods of support systems. Blasting in Underground Excavation and Instrumentation: Basic mechanics of explosive rock breaking; Creation of free space; Rock damage, and design of blasting patterns. Instrumentations: Objectives and types of underground instrumentation; Monitoring of underground excavations during and after construction.

References:

1. R. E Goodman. *Introduction to Rock Mechanics*. John Wiley and Sons, 1989
2. Evert Hoek, Jonathan D. Bray*, Rock Slope Engineering*, (3e), 1981
3. E Hoek, E. Brown, *Underground excavations in rock*, CRC Press, 1980
4. T. Ramamurthy, *Engineering in Rocks for Slopes, Foundations and Tunnels*. Prentice Hall India, 2007.
5. Z.T. Bieniawski, *Rock mechanics in mining & tunnelling*. A.A. Balkema, 1984

CV4151: URBAN TRANSPORTATION PLANNING [2 1 0 3]

Introduction to Urban Transportation, Mass transportation characteristics, Demand Characteristics: Spatial, Temporal and behavioural characteristics; Introduction to Public Transport: Public transport Travel characteristics, Trip chaining, Technology of bus, Rail, Rapid transit systems, Basic operating elements; Transit Network Planning: Planning Objectives, Principles, Considerations, Transit lines types, Transit routes and their characteristics, Timed transfer networks, Prediction of transit usage, Evaluation of network, Accessibility considerations; Transit Scheduling: Components of scheduling process, Service requirements, Scheduling procedure, Marginal ridership, Crew scheduling; Transit Agency and Economics: Organizational structure of transit agency, Management and

personnel, Transit system statistics, Performance and economic measures, Operations, Fare structure; Terminals and Depots: Design of bus stops, Design of terminals - principles of good layout, Types of layout, Truck terminal, Depot location, Twin depot concept, Crew facilities and amenities; Special Systems: People mover systems, Underground transportation, Para transit, High Speed Rail transit system, case studies.

References:

1. K. Lal, *Transportation Engineering*, (4e), PHI Delhi, 2012
2. W. W. Hay, *An Introduction to Transportation Engineering*, (2e), John Wiley & Sons, 2010
3. L. R. Kadiyali, *Traffic Engineering and Transport Planning*, (4e), Khanna Publishers, 2006
4. Hutchinson, *Urban Transport Planning*, (3e), John Wiley, 2006

CV4152: TRAFFIC SYSTEMS AND ENGINEERING [2 1 0 3]

Road Characteristics – Road user characteristics – PIEV theory – Vehicle Performance characteristics – Fundamentals of Traffic Flow – Urban Traffic problems in India – Integrated planning of town, country, regional and all urban infrastructure – towards Sustainable approach. – land use & transport and modal integration. Traffic Surveys – Speed, journey time and delay surveys – Vehicles Volume Survey including non-motorized transports – Methods and interpretation – Origin Destination Survey – Methods and presentation – Parking Survey – Accident analyses - Methods, interpretation and presentation – Statistical applications in traffic studies and traffic forecasting – Level of service – Concept, applications and significance. Intersection Design – channelization, Rotary intersection design – Signal design – Coordination of signals –– Grade separation – Traffic signs including VMS and road markings – Significant roles of traffic control personnel – Networking pedestrian facilities & cycle tracks. Road accidents – Causes, effect, prevention, and cost – Street lighting – Traffic and environment hazards – Air and Noise Pollution, causes, abatement measures – Promotion and integration of public transportation – Promotion of non-motorized transport. Area Traffic Management System – Traffic System Management (TSM) with IRC standards –- Traffic Regulatory Measures-Travel Demand Management (TDM) – Direct and indirect methods – Congestion and parking pricing – All segregation methods- Coordination among different agencies – Intelligent Transport System for traffic management, enforcement and education.

References:

1. L. R. Kadiyali, *Traffic Engineering and Transport Planning*, Khanna Publishers, Delhi, 2013
2. Indian Roads Congress (IRC) Specifications: Guidelines and Special Publications on Traffic Planning and Management
3. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, *Principles of Highway Engineering and Traffic Analysis*, Wiley India Pvt. Ltd., New Delhi, 2011
4. SP:43-1994, IRC Specification, "Guidelines on Low-cost Traffic Management Techniques" for Urban Areas, 1994
5. C. Jotin Khisty, B. Kent Lal, *Transportation Engineering*, 3rd edition

CV 4153: HYDROLOGICAL ANALYSIS [2 1 0 3]

Introduction, Hydrological cycle, Scope and application of hydrology, Geomorphology of drainage basins. Analysis of precipitation data, Abstractions: Runoff, Hydrographs, Floods, Hydrological Modelling

References:

1. Linsley, Pauler, Kohlas, *Hydrology for Engineers*, MGH Publishers, Tokyo. 1975
2. Linsley, Kohler, Paulhus, *Applied hydrology*, MGH Publications, New York. 1949
3. VenTe Chow, D. R. Maidment, L.W. Mays, *Applied Hydrology*, McGraw Hill. 1998
4. H. M. Raghunath, *Hydrology*, Wiley Eastern publications, Delhi, 1985
5. W. Viessman, J. Knapp, *Introduction to hydrology*, Harper & Row publishers, 1989

CV4154: WATER RESOURCES PLANNING AND MANAGEMENT [2 1 0 3]

Capability & requirements of multipurpose projects, Data collection Conjunctive-use management, Reservoir Planning & Operation, Canal Management: River Training methods & structures, Economics of Water Resource Projects, Cost-Benefit analysis, Socio-Legal & Environmental Aspects

References:

1. D.P Loucks, Eelco van Beek. *Water resources systems planning and management*: *An introduction to methods, models and applications*, UNESCO. 2005

2. S. Vedula, P. P. Mujumdar. *Water resources systems: Modeling techniques and analysis*, Tata McGraw Hill, New Delhi 2005.
3. L. W. Mays, Y. K. Tung, *Hydro systems engineering and management*, McGraw Hill, USA 1992.
4. S. P. Simonovic*, Managing water resources: Methods and tools for a systems approach*, UNESCO publishing, France 2009.

CV4155: BRIDGE ENGINEERING [2 1 0 3]

Introduction: Definitions, Components of a bridge, Classification, Importance and standard specifications; Investigation for bridge: Site selection, Data drawing, Design discharge linear Water way, Economical span, Location of piers and abutments, Vertical clearance above HFL, Scour depth; Traffic Projection, Investigation Report, Choice Of Bridge Type. Standard Specifications for Road Bridge: IRC bridge code, Determination of dead loads and live loads, Wind loads, Longitudinal forces, Centrifugal forces, Horizontal forces due to water current buoyancy effect, Earth pressure, Temperature effect, Deformation stresses, Secondary stresses, Erection stresses, Seismic forces; Culverts: RCC slab culvert, Pipe culverts and box culvert; Concrete Bridges: T-beam Reinforced Concrete Bridges and Pre Stressed Concrete Bridges, Continuous bridges, Cantilever bridges; Substructures: Different types of bridge bearings, Piers and masonry abutments, Different types of foundations and their choices, Wing walls.

References:

1. D. J. Victor, *Essentials of Bridge Engineering*, Oxford & IBH Publishing Co. Pvt. Ltd., 2015.
2. N. K. Raju, *Design of Bridges*, Oxford & IBH Publishing Co. pvt. Ltd, 2008.
3. S. Ponnusamy, Bridge Engineering, Tata McGraw Hill Publishing Co., New Delhi, 2008.
4. Indian Road Congress Codes No.5-1998, Jamnagar House, Shah Jahan Road, New Delhi.
5. Indian Road Congress Codes No.6-2014, Jamnagar House, Shah Jahan Road, New Delhi.
6. Indian Road Congress Codes No.18-2000, Jamnagar House, Shah Jahan Road, New Delhi.
7. Indian Road Congress Codes No.21-2000, Jamnagar House, Shah Jahan Road, New Delhi.
8. Indian Road Congress Codes No.24-1967, Jamnagar House, Shah Jahan Road, New Delhi.

OPEN ELECTIVES

CV2080: ENVIRONMENTAL IMPACT ASSESSMENT [3 0 0 3]

Introduction and concepts: Definitions and concepts, rationale and historical development of EIA, EIA laws and regulations, The Environmental Protection Act, The Water Prevention Act, The Air (Prevention & Control of Pollution Act.), Wild life Act etc. EIA Methodologies: introduction, Criteria for the selection of EIA Methodology, EIA methods, Effect of human activity on environment, concept of eco-system imbalances, definition of EIA, EIS, EMP, industrial policy of the Govt. of India. Prediction and Assessments of Impacts: Impacts on air, water, biota, noise, cultural and socio-economic environment. Air Quality Impact: Air quality indices, air quality impact of industry transport systems, human settlements. Methods of assessment, mitigation of impact. Water quality impact: Water quality criteria, standards and indices, Impacts on water quality of development projects. Biota and noise: Impact on flora and fauna, mitigation measures, alternatives. Effects of noise on people, noise scales and rating methods. Estimating transportation noise impacts. Cultural and socio economic impacts: Effect of developmental projects on cultural and social settings and economic profile of the community. Methodologies for EIA: Preliminary assessment, quantification, comparison of alternatives and comprehensive EIA's. Environmental audit: meaning and importance.

References:

1. C. C. Lee, S. D. Lin, *Handbook of Environmental Engineering Calculations*, McGraw Hill, New York, 1999.
2. C. N. Sawyer, P. L. McCarty, *Chemistry for Environmental Engineering and Science*, 5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2003.
3. A.C. Stern, *Air Pollution*, Academic Press, Inc. New York, 1991.
4. P. Wathern, *Environmental Impact Assessment: Theory and Practice*, Taylor & Francis, New York, 2002.
5. Y. Anjaneyulu, *Environmental Impact Assessment Methodologies*, B.S. Publications; New Delhi, 2 editions, 2010.

CV2081: CONTRACT MANAGEMENT [3 0 0 3]

Project Cost Estimation, rate analysis, overhead charges, bidding models and bidding strategies, Owner's and contractor's estimate; Pre-qualification of bidders and enlistment of contractors; Tendering and contractual procedures: Indian Contract Act1872, Definition of Contract and its applicability, Types of contracts, International contracts, FIDIC, Conditions and specifications of contract; Contract administration, Duties and responsibilities of parties; Claims, compensation and disputes; Dispute resolution techniques, Arbitration and Conciliation Act 1996, Arbitration case studies, Negotiation

References:

1. B. S. Patil, *Civil Engineering Contracts and Estimates*, University Press, 2009.
2. G. Betty John, *Engineering Contracts*, McGraw Hills 19
3. B. J. Vasavada, *Engineering Contracts and Arbitration*, Jubilee Publications, 2nd Edition, 1996.
4. K. N. Vaid, *Global perspective on International Construction Contracting Technology and Project Management*, NICMAR.

CV2082: BUILDING PLANNING [3 0 0 3]

Introduction: Significance of building planning, NBC Classification of buildings, Orientation: Meaning, factors affecting orientation, orientation criteria for tropical climate. Sun Considerations: Different methods of drawing sun chart, sun shading devices, energy conservation in buildings, passive solar cooling and heating of buildings. Climatic and comfort Consideration: Elements of climate, introduction to global climate, climatic zones of India, comfort conditions, bi-climatic chart, climate modulating devices. Building Bye Laws: Objective of by-laws, NBC Regulation regarding; means of access, lines of building frontages, covered area, floor area ratio, open spaces around buildings, height & sizes of rooms, plinth regulation and sanitation provisions. Principles of Planning: Different factors affecting planning, prospect, furniture requirement, roominess, grouping, circulation, elegance, privacy. Residential Buildings: Anthropometry, activities and their spatial requirements; Area planning, living area, sleeping area, service area; Bubble diagram showing sequence of arrangement of area, plan, elevation, sectional elevation. Buildings Services: Lighting and ventilation, doors and windows, lifts, Acoustics, sound insulation and noise control, Firefighting provisions.

References:

1. Bureau of Indian Standards, National Building Code, 2016
2. M. Karlen, *Space Planning Basics*, John Wiley & Sons; 2nd Edition, 2003.
3. O. H. Koenigsberger, T. G. Ingersoll, A. Mayhew, S. V. Szokolav, *Manual of Tropical Housing and Buildings*, Universities Press, 2014.
4. S. S. Bhavikatti, M. V. Chitawadagi, *Building Planning and Drawing*, I K International Publishing House, 2014.
5. SP41

CV3080: GEOGRAPHICAL INFORMATION SYSTEM [3 0 0 3]

Introduction and concepts of Remote Sensing, Spectral response pattern, aerial photography. Satellite remote sensing: Data acquisition, digital image processing, spectro-radiometer. Remote sensing satellites: Land observation satellites and applications. Types of remote sensing and image interpretation: optical remote sensing, visible, infrared, thermal sensors, concept of microwave remote sensing and sensors, SLAR, SAR scatterometer, image interpretation characters. Geographical Information System (GIS): Database, raster and vector data, database management system, Digital Elevation Models (DEM) and applications, strategies involved in GIS, GIS applications; land use and land cover, water and land resources, environment and traffic system.

References:

1. M. N. Demers, *Fundamentals of Geographic Information Systems*, (3e), John Wiley and Sons, 2012.
2. B. Bhatta, *Remote Sensing and GIS*, (2e), Oxford University Press, 2011.
3. K. T. Chang, *Introduction to Geographic Information Systems*, McGraw-Hill Book Company, 2006.
4. J. B. Cambell, *Introduction to Remote Sensing*, UK, Taylor & Francis, 2002.
5. P. A. Burrough, R. A. McDonnell, *Principles of Geographical Information Systems*, (2e), Oxford University Press, 1998.
6. F. F. Sabins Jr, *Remote Sensing - Principles and Interpretation*, New York, USA, W. H. Freeman & Co., 1986.

CV3081 ENVIRONMENTAL MANAGEMENT [3 0 0 3]

Business and sustainability: Economy and sustainable development. Strategies for SD, Green business and rankings. Environmental reporting. Ecology and ecosystem: Definition, concept of ecosystems, structure and function, food chains and food webs. Features of various ecosystems and Ecological succession. Biodiversity: Introduction, types of biodiversity, threats to biodiversity. Conservation of biodiversity. Environment and its components, Pollution and Pollution control, Global warming and climate change, Environmental management system: Introduction to EMS, Scope and importance, Dimensions and Principles of EM, Sustainable Development, Environmental impact assessment and auditing. Environmental decision making. Environmental laws and policies: Chronology of environmental laws in India. Clearance and permissions for establishing industry. International agreements, laws and treaties.

References:

1. A. R. N. Sankar, *Environmental Management*, Oxford University Press, New Delhi, 2015.
2. M. M. Sulphey, *Introduction to Environmental Management*, PHI Learning, New Delhi, 2013.
3. C. C. Lee, S. D. Lin, *Handbook of Environmental Engineering Calculations*, McGraw Hill, New York, 1999.
4. C. N. Sawyer, P. L. McCarty, *Chemistry for Environmental Engineering and Science*, 5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2003.

CV3082: ADVANCED FLUID MECHANICS [3 0 0 3]

Basic Concepts and Fundamentals, Fluid statics, Fluid Kinematics, Governing Equations of Fluid Motion, Integral and Differential Forms of Governing Equations, Laminar Boundary Layers, Turbulent Flows Turbulent boundary layer equation, Turbulent pipe flow, Compressible Flows.

References:

1. G. K. Batchelor, *An Introduction to Fluid Dynamics*, Cambridge University Press, 1983.
2. T. W. F Robert, Alan McDonald, *Introduction to Fluid Mechanics*, Fourth Edition, John Wiley & Sons, 1995.
3. M. W. Frank, *Fluid Mechanics*, Tata McGraw-Hill, Singapore, Sixth Edition, 2008.
4. K. Muralidhar, G. Biswas, *Advanced Engineering Fluid Mechanics*, Second Edition, Narosa, 2005.

CV3083 SOLID WASTE MANAGEMENT [3 0 0 3]

Introduction: Sources and classification of solid waste, Causes of solid waste pollution, Generation and composition of waste, characteristics of solid waste, collection, transport and storage, concept of waste segregation at source, recycling and reuse of waste. Technology: waste treatment technologies, source reduction techniques, product recycling and recovery, incineration and energy recovery, recovery of biological conversion of product. Disposal and Management: waste disposal, management of leachate and landfill gases, hazardous and biomedical waste management and treatment. Rules and Regulation: regulatory requirement applicable to solid waste management.

References:

1. A. D. Bhide, B. B. Sundaresan, *Solid Waste Management for Developing Countries*, Indian National Scientific Documentation Centre, 1983.
2. T. V. Ramachandra, *Management of Municipal Solid Waste*, The Energy and Resources Institute (TERI), 2009.
3. G. Tchobanoglous, F. Kreith, *Integrated Solid Waste Management*, McGraw Hill Education; 1st Edition, 2014.
4. Manual on SWM, GOI, CPHEEO

CV3084: RURAL WATER SUPPLY AND SANITATION [3 0 0 3]

General: Importance of protected water supply, investigation and selection of water sources, Hand pump Technology, its operation and maintenance. Rain water harvesting techniques and uses. Quality of water: drinking water quality standards, estimation of total water requirement including cattle water demand. Communicable Diseases: Terminology, classification, methods of communication, general methods of control. Water Treatment: slow sand filter, horizontal roughing filter and their combination, disinfection of rural water sources, fluoride and its removal. Milk and Food sanitation: Essentials of dairy farm and cattle shed sanitation, Fly and Mosquito control: Life cycle of flies and mosquitoes, various methods of flies and mosquito control. Rural Sanitation: Conservancy, Village latrines, VIP latrines, pour flush latrines, materials, construction and cost of the latrines, concept of eco-sanitation.

septic tank, soak pit, storm water and sludge disposal problems, animal waste, method of composting, Biogas, collection and disposal of wastes. Reuse collection and disposal: Garbage, ash, rubbish, collection, transportation, disposal methods. Botulism.

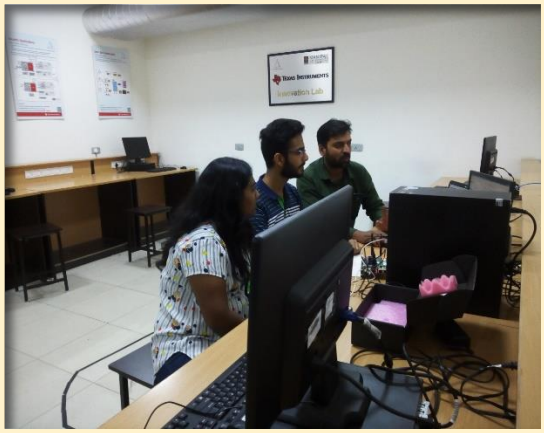
References:

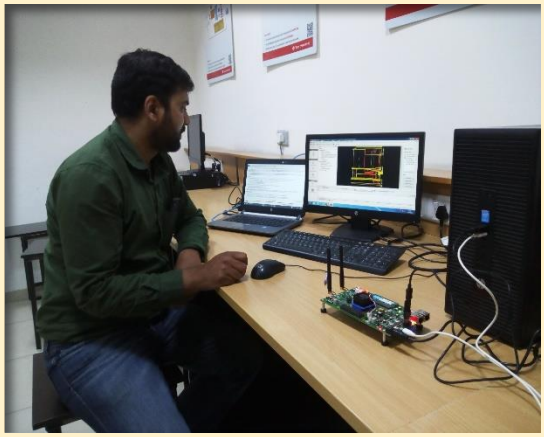
1. H. T. Mann, D. Williamson, *Water Treatment and Sanitation – Simple Method for Rural Area*, Intermediate Technology Publications, 1973.
2. E. W. Steel, *Municipal and Rural Sanitation*, Mc Graw Hill Book Co. 1927
3. E. G. Wanger, J. N. Lanoix, *Water Supply for Rural Areas & Small Communities*, World Health Organization 1959
4. F. Brikké, *Operation and maintenance of rural water supply and sanitation systems*, 2000.

Department of Computer and Communication Engineering

Department of Computer & Communication Engineering (CCE) at Manipal University Jaipur marked its commencement in 2015. The goal of the department is to integrate computer and communication, which includes concepts and practices of software and hardware of computers, information networks, wireless communication systems etc. The Department of CCE offers one of the most comprehensive instructional programs enhanced with research in its emerging fields. Research at the department addresses issues across the spectrum of Computer as well as Communication engineering systems. Some of the key areas include Machine Learning, Internet of Things (IoT), Web Technologies, Advance Computer Networking, Network and Information Security, Wireless Communication, Network on Chip (NoC), Software Testing, Computer Architecture and Embedded Systems. Excellent labs and state-of-art infrastructure. Salient features are:

- Experienced and learned Faculty Members
- Advanced and comprehensive course curriculum
- Impart learning through practical lab sessions and projects
- Flexibility and diversity in electives
- Realistic approach towards market demands and industrial needs
- Focus on innovation and research





B.Tech in Computer and Communication Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Course Name	L	T	P	C	Course Code	Course Name	L	T	P	C
II	EO2001	Economics	3	0	0	3	BB0025	Value, Ethics and Governance	2	0	0	2
	MA2101	Engineering Mathematics III	2	1	0	3	MA2201	Engineering Mathematics IV	2	1	0	3
	CC2101	Digital Design and Computer Architecture	3	1	0	4	CC2201	Computer Networks	3	1	0	4
	CC2102	Data Communications	3	1	0	4	CC2202	Relational Database Management Systems	3	1	0	4
	CC2103	Data Structures and Algorithms	3	1	0	4	CC2203	Operating Systems	3	1	0	4
	CC2104	Object Oriented Programming	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	CC2130	Data Communications Lab	0	0	2	1	CC2230	Computer Networks Lab	0	0	2	1
	CC2131	Data Structures and Algorithms Lab	0	0	2	1	CC2231	Relational Database Management Systems Lab	0	0	2	1
	CC2132	Object Oriented Programming Lab	0	0	2	1	CC2232	Operating Systems Lab	0	0	2	1
			17	5	6	25			16	4	6	23
	Total Contact Hours (L + T + P)		28				Total Contact Hours (L + T + P)+OE		26			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	CC3101	Software Engineering	3	1	0	4	BB0026	Organization and Management	3	0	0	3
	CC3102	Design and Analysis of Algorithms	3	1	0	4	CC3201	Artificial Intelligence and Machine Learning	3	1	0	4
	CC3103	Foundations of Data Science	3	1	0	4	CC3202	Wireless Communications	3	1	0	4
	CC3104	Cryptography and Security	3	1	0	4	CC3203	Automata Theory and Compiler Design	3	0	0	3
	CC31XX	Program Elective – I	3	0	0	3	CC32XX	Program Elective – II	3	0	0	3
	It XXXXXX	Open Elective – II	3	0	0	3	XXXXXX	Open Elective – III	3	0	0	3
	CC3130	Software Engineering Lab	0	0	2	1	CC3230	Artificial Intelligence and Machine Learning Lab	0	0	2	1
	CC3131	Design and Analysis of Algorithms Lab	0	0	2	1	CC3231	LINUX Shell Programming Lab	0	0	2	1
							CC3270	Minor Project	0	0	6	3
			18	4	4	24			18	2	10	25
	Total Contact Hours (L + T + P)+OE		26				Total Contact Hours (L + T + P)+OE		30			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	CC41XX	Program Elective – III	3	0	0	3	CC4270	Major Project				12
	CC41XX	Program Elective – IV	3	0	0	3						
	CC41XX	Program Elective – V	3	0	0	3						
	CC41XX	Program Elective – VI	3	0	0	3						
	CC41XX	Program Elective – VII	3	0	0	3						
	CC4170	Industrial Training	0	0	2	1						
			15	0	2	16						12
	Total Contact Hours (L + T + P)		15+0+2=17				Total Credits=169(including first year)					

THIRD SEMESTER

EO2001: Economics [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H. L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H. C. Peterson, *Managerial Economics*, (9e), 2012.
3. P. L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G. J. Tuesen, H.G. Tuesen, *Engineering Economics*, Prentice Hall of India.
5. J. L. Riggs, D.D. Bedworth, S. U. Randhawa, *Engineering Economics*, McGraw Hill.

MA2101: Engineering Mathematics III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices and Boolean Algebra. Propositional and Predicate Calculus: Wellformed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. Elementary configuration: Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. Ordering of permutations: Lexicographical and Fikes. Graph theory: Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path, Algorithm. Group theory: Semi groups, Monoids, Groups subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. C. L. Liu, *Elements of Discrete Mathematics,* (2e), McGraw Hill, New Delhi, 2007.
2. J. P. Trembaly, R. Manohar, *Discrete Mathematics Structures with application to computer science*, McGraw Hill, 2012.
3. E. S. Page, L. B. Wilson, *An Introduction to Computational Combinatorics*, Cambridge Univ. Press, 1979.
4. N. Deo, *Graph theory with Applications to computer science*, Prentice Hall of India, 2012.

CC2101: DIGITAL DESIGN AND COMPUTER ARCHITECTURE [3 1 0 4]

Digital logic circuits: logic gates, Boolean algebra, map simplification, combinational circuits, flip-flops, sequential circuits; Digital components: Integrated circuits, decoders, multiplexers, registers, shift registers, binary counters; Memory unit: Von-Neumann model for computer/ Von-Neumann architecture, performance; Machine instructions and programs: numbers, arithmetic operations and characters, memory locations and addresses, instructions and instruction sequencing, addressing modes, assembly language, additional instructions, encoding of machine instructions; Arithmetic: addition and subtraction of signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication, fast multiplication, integer division, floating point numbers and operations; Introduction to CPU design: instruction interpretation and execution, micro-operation and their RTL specification, memory hierarchy, main memory, types and interfacing; Cache Memory: organization and operations, levels of caches; memory management module: paging and segmentation, virtual memory, disk memory, raids, back-up memory; RISC and CISC processors; Introduction to input/output processing: programmed controlled i/o transfer, interrupt controlled I/O transfer, DMA controller; Pipelining and pipeline hazards: design issues of pipeline architecture; Instruction level parallelism and advanced issues: introduction to interconnection network and practical issues.

References:

1. M. M. Mano, *Computer System Architecture*, (3e), Pearson Education, 2014.

2. C. Hamacher, Z. Vranesic, S. Zaky, *Computer Organization*, (6e), McGraw Hill, 2011.
3. J. P. Hayes, *Computer Architecture and Organization*, (3e), McGraw Hill, 2017.
4. T. L. Floyd, *Digital Fundamentals*, (10e), Pearson Education, 2014.
5. W. Stallings, *Computer Organization and Architecture–Designing for Performance*, (8e), Pearson Education, 2010.

CC2102: Data Communications [3 1 0 4]

Introduction: General block diagram of communication system, Data communications, Protocol, Need for Protocol Architecture, OSI Model, TCP/IP Protocol Architecture; Data Transmission: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity; Transmission Media: Guided Transmission Media, Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission; Signal Encoding Techniques: Analog and Digital Signals, Digital-To-Digital Conversion: Line Coding Schemes, Block Coding, Scrambling, Analog-To-Digital Conversion: Pulse Code Modulation, Delta Modulation; Digital Data Communication Techniques: Asynchronous and Synchronous Transmission, Types of Errors, Error Detection, Error Correction, Line Configurations; Data Link Control Protocols: Flow Control, Error Control, High-Level Data Link Control (HDLC); Multiplexing: Frequency-Division Multiplexing (FDM), Time-Division Multiplexing (TDM); Spread Spectrum: The Concept of Spread Spectrum, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS); Multiple Access-Aloha, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), Code-Division Multiple Access (CDMA); Introduction to IEEE 802.X LAN Standards.

References:

1. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2014.
2. B. A. Forouzan, *Data Communications & Networking*, (5e), McGraw Hill, 2013.
3. D. P. Bertsekas, R. G. Gallager, *Data Networks*, (2e), Prentice Hall of India, 2011.
4. A. S. Tenenbaum, *Computer Networks*, (5e), Prentice Hall of India, 2008.
5. L. L. Peterson, B. S. Davie, *Computer Networks: A Systems Approach*, (5e), Morgan Kaufmann Publishers, 2011.

CC2103: DATA STRUCTURES and ALGORITHMS [3 1 0 4]

Introduction: algorithm specification; Performance analysis: time and space complexity, asymptotic notation; C revision: pointer declaration and definition, memory allocation functions, array of pointers, structures in C, arrays of structures, structures and functions; Recursion in C; Linked list: implementation, various types and operations; Stack: implementations using array and linked list, operations and its applications; Queue: implementations using array and linked list, operations and its applications; Tree: terminologies, different types, implementations of binary tree using array and linked structure, binary search tree, different operations (recursive, non-recursive), red-black tree, AVL trees, B-tree, 2-3 tree, tree applications; Graph: representations, BFS, DFS; Searching techniques and hashing; Sorting.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, *Fundamentals of Data Structures in C*, (2e), Orient Black Swan, 2008.
2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, *Data Structures using C*, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, *Data Structures and Algorithms*, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to algorithms*, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, *Data Structures with C (Schaum's Outline Series)*, (3e), McGraw Hill, 2011.
6. M. A. Weiss*, Data structures and Algorithm Analysis in C,* (1e), Pearson Education, 2002.

CC2104: OBJECT ORIENTED PROGRAMMING [3 1 0 4]

Introduction: history and evolution of OOP, Introduction to OOPS and classes: class and object fundamentals, introduction to methods/functions, object initialization and clean-up (constructors and destructors), this keyword, overloading, objects as parameters, argument passing, returning objects, recursion, access control, classes within classes, string class; I/O basics: reading console input, writing console output, files; Inheritance: basics, multilevel hierarchy, overriding, abstract classes; Packages and Interfaces; exception handling; Multithreaded programming;

String handling; Event handling; GUI and Introduction to AWT: classes, component, container, panel, window, frame, canvas, working with frame, working with graphics, Applet fundamentals; The collection framework: array list and vector, sets, map; Database programming using JDBC; Java Server Technologies: servlet; introduction to JDK, JRF and JVM, variables and data types, Unicode system, naming conventions;

References:

1. H. Schildt, *Java:The Complete Reference Java*, (10e), McGraw Hill, 2017.
2. C. Horstmann, *Core Java Volume-1 Fundamentals*, (10e), Prentice Hall of India, 2016.
3. S. Holzner, *Java 8 programming black book*, (1e), Dream Tech, 2015.
4. P. Deitel, H. Deitel, *Java How to Program*, (11e), Pearson Education, 2018.
5. E. Balagurusamy, *Programming with Java A Primer*, (5e), McGraw Hill, 2017.

CC2130: DATA COMMUNICATIONS LAB [0 0 2 1]

Signal Modulation Techniques: ASK, PSK, FSK, Pulse Code Modulation (PCM), Delta Modulation; CDMA; Various Line Coding Techniques; Packet Tracer: Introduction, PC to PC Communication using Crossover Cable, Star Topology Using Hub and Switch as Network Devices; Study using Wireless Open Access Research Platform (WARP).

References:

1. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2014.
2. B. A. Forouzan, *Data Communications & Networking*, (5e), McGraw Hill, 2013.
3. D. P. Bertsekas, R. G. Gallager, *Data Networks*, (2e), Prentice Hall of India, 2011.
4. A. S. Tenenbaum, *Computer Networks*, (5e), Prentice Hall of India, 2008.
5. L. L. Peterson, B. S. Davie, *Computer Networks: A Systems Approach*, (5e), Morgan Kaufmann Publishers, 2011.

CC2131: DATA STRUCTURES AND ALGORITHMS LAB [0 0 2 1]

Array: application using arrays (1-D, 2-D), string operations; Linked list: applications (singly, doubly, circular, etc) like polynomial addition and multiplications, etc, Stack and queue: applications of stacks (like arithmetic expression conversion and evaluation, etc), applications of queue; Binary tree: creation, deletion and traversal techniques, Binary search tree operations, AVL tree; sorting and searching techniques.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, *Fundamentals of Data Structures in C*, (2e), Orient Black Swan, 2008.
2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, *Data Structures using C*, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, *Data Structures and Algorithms*, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to algorithms*, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, *Data Structures with C (Schaum's Outline Series)*, (3e), McGraw Hill, 2011.
6. M. A. Weiss*, Data structures and Algorithm Analysis in C,* (1e), Pearson Education, 2002.

CC2132: OBJECT ORIENTED PROGRAMMING LAB [0 0 2 1]

Introduction to Java basics; Control statements and arrays; Stacks and lists; Strings; Classes and methods; Inheritance; Packages; Interfaces; Exception handling; Threads; Input/output; Event handling; Applets; Programs involving AWT; Swing; JDBC; Servlet.

References:

1. H. Schildt, *Java:The Complete Reference Java*, (10e), McGraw Hill, 2017.
2. C. Horstmann, *Core Java Volume-1 Fundamentals*, (10e), Prentice Hall of India, 2016.
3. S. Holzner, *Java 8 programming black book*, (1e), Dream Tech, 2015.
4. P. Deitel, H. Deitel, *Java How to Program*, (11e), Pearson Education, 2018.
5. E. Balagurusamy, *Programming with Java A Primer*, (5e), McGraw Hill, 2017.

FOURTH SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B. N. Ghosh, *Business Ethics & Corporate Governance*, (1e), McGraw Hill, 2011.
3. S. K. Mandal, *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. C. K. Ray, *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. A. Chatterjee, *Professional Ethics*, (2e), Oxford Publications.

MA2201: Engineering Mathematics IV [2 1 0 3]

Basic Set theory, Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One dimensional and two dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. Functions of random variables: One dimensional and Two dimensional, F & T distributions, Moment generating functions, Sampling theory, Central limit theorem, Point estimation, MLE, Interval estimation, Test of Hypothesis: significance level, certain best tests; Chi square test.

References:

1. P. L. Meyer, *Introduction to probability and Statistical Applications*, (2e), Oxford and IBH publishing, 1980.
2. Miller, Freund and Johnson, *Probability and Statistics for Engineers*, (8e), Prentice Hall of India, 2011.
3. Hogg and Craig, *Introduction to mathematical statistics*, (6e), Pearson Education, 2012.
4. Sheldon M Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier, 2010

CC2201: Computer Networks [3 1 0 4]

Network Layer: network layer design issues, routing algorithms, congestion control algorithms, Quality of Service (QoS), MPLS; Classful addressing, subnetting, classless addressing, variable length blocks, block allocation, NAT; IPV4: header format, fragmentation, options, checksum; ARP & DHCP: introduction, packet format, message types; ICMP: message format, message types; Dynamic routing protocols: RIP, OSPF & BGP, Multicasting Protocol: IGMP; Introduction to IPV6; Transport Layer: elements of transport protocols: addressing, connection establishment, connection release, congestion control, transport services, transport layer protocols, state diagrams; UDP: UDP datagram, UDP services, checksum; TCP: TCP services, TCP features, segment, TCP connection establishment, data transfer, connection termination, TCP window management, flow control, congestion control, timer management; Application Layer: DNS: Name space, domain resource records, Electronic Mail - SMTP, POP, IMAP, MIME, HTTP, HTTPS, SNMP.

References:

1. B. A. Forouzan, *TCP/IP Protocol Suite*, (4e), McGraw Hill, 2010.
2. A. S. Tenenbaum, *Computer Networks*, (5e), Prentice Hall of India, 2008.
3. D. E. Comer, *Internetworking with TCP/IP Principles, Protocols and Architecture*, (6e), Pearson Education, 2014.
4. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2014.

CC2202: RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: database systems, RDBMS definition, data models, 3-schema architecture, challenges in building RDBMS, different components of a RDBMS. Relational data model: concept of relation and its characteristics, schema-instance, integrity constraints, E/R Model, Extended E/R model, converting the database specification in E/R

and Extended E/R notation to the relational schema; Relational Query Language: relational algebra operators - selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus; Introduction to SQL: data definition in SQL, table and different types of constraints definitions, data manipulation in SQL, nested queries, notion of aggregation; Relational Database Design: functional dependencies and normal forms, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF; Transaction Processing: concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods; Data Storage and Indexing: file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B-tree and B+ trees.

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.
4. I. Bayross, *SQL, PL/SQL The Programming Language of Oracle*, (4e), BPB Publications, 2010.
5. C. J. Date, *An Introduction to Database Systems*, (8e), Prentice Hall of India, 2006.

CC2203: OPERATING SYSTEMS [3 1 0 4]

Introduction: evolution of operating system, classification of operating system, operating system structure, services, functions, design and implementation, system programs, system calls, virtual machines, system boot; processes: concept, process scheduling, operations on processes, inter-process communication; Linux threads: basic concepts, multithreaded models, thread libraries; CPU scheduling: scheduling criteria, scheduling algorithms, thread scheduling; Process synchronization: concept of synchronization, critical section problem, Dekker's algorithm, peterson's solution, synchronization hardware, semaphores, classical problems on synchronization, monitors; Deadlock: deadlock concept, deadlock characterization, methods for handling deadlock, prevention, avoidance, detection, recovery from deadlock; Memory management: concept of logical and physical memory, swapping, contiguous memory allocation, paging, page table structure, segmentation, paging combined with segmentation, working of intel-32/64; Virtual memory management: demand paging, copy-on write, page replacement, allocation of frames, thrashing, memory mapped files, allocating kernel memory; Files: file concept, access methods, directory structure, file system mounting, file sharing; Disk: architecture, scheduling algorithms; Security problem: program threats, system and network threats; Case study: Linux / Solaris / Mac / Windows operating system.

References:

1. A. S. Tannenbaum, *Modern Operating Systems*, (4e), Pearson, 2014.
2. A. Silberschatz, P. B. Galvin, *Operating System Concepts*, (8e), International student version, Wiley, 2009.
3. W. Stallings, *Operating Systems: Internals and Design Principles*, (9e), Pearson, 2009.
4. H. Sibsankar, A. A. Alex, *Operating Systems*, (6e), Pearson, 2009.
5. W. Stallings, *Operating Systems Design and Implementation*, (3e), Prentice Hall Software Series, 2008.
6. J. A. Harris, *Schaum's Outline of Operating Systems*, (2e), McGraw-Hill publications, 2002.

CC2230: Computer Networks Lab [0 0 2 1]

Experiment with Packet Tracer: Introduction to Packet tracer and networking device components; Router Mode, Switch/Router basic commands; designing of star topology using HUB and Switch, IP configuration of end devices; configuring DHCP server, static routing, RIP, OSPF, VLAN and NAT; Network programming: Transmission Control Protocol (TCP) socket and User Datagram Protocol (UDP) socket; Network Utilities: PING, NETSTAT, IPCONFIG, IFCONFIG, ARP, TRACE-ROUTE

References:

1. B. A. Forouzan, *TCP/IP Protocol Suite*, (4e), McGraw Hill, 2010.
2. A. S. Tenenbaum, *Computer Networks*, (5e), Prentice Hall of India, 2008.
3. D. E. Comer, *Internetworking with TCP/IP Principles, Protocols and Architecture*, (6e), Pearson Education, 2014.
4. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2014.

CC2231: RELATIONAL DATABASE MANAGEMENT SYSTEMS LAB [0 0 2 1]

Introduction to SQL and its different command categories i.e. DDL, DML, DQL and DCL; Data integrity constraints and built-in functions; Design and implementing the data requirements of a simple DB application; Experiments on views, indexing, triggers, stored procedures, transaction. Platforms: Oracle and/or MySQL

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.
4. I. Bayross, *SQL, PL/SQL The Programming Language of Oracle*, (4e), BPB Publications, 2010.
5. C. J. Date, *An Introduction to Database Systems*, (8e), Prentice Hall of India, 2006.

CC2232: OPERATING SYSTEMS LAB [0 0 2 1]

Testing the use of UNIX commands; Working with VI editor; Shell: UNIX shell commands, System Administration: user management, security, file management; Inter-process communication: shared memory, message passing, pipes; UNIX system calls: system calls for process management, file management; Process synchronization: bounded buffer problem, Peterson's solution, semaphore; Building multi-threaded and multi-process applications: multi-threading using pthread library; CPU scheduling algorithms; Deadlock: detection algorithms, deadlock avoidance algorithms; Page replacement algorithms; Memory allocation algorithms; Disk scheduling algorithms.

References:

1. S. Das, Unix Concepts and Applications, (4e), McGraw-Hill Publications, 2017.
2. R. Blum, C. Bresnahan, Linux Command Line and Shell Scripting Bible, (3e), Wiley India, 2015.
3. A. Silberschatz, P. B. Galvin, Operating System Concepts, (8e), International student version, John Wiley & Sons, 2009.

FIFTH SEMESTER

CC3101: SOFTWARE ENGINEERING [3 1 0 4]

Software Engineering: introduction, importance, evaluation, characteristics and components; Software applications; Software development process models: waterfall model, prototyping model, spiral model, RAD model; agile modelling; Requirement engineering: problem analysis, requirement verification, requirement validation modularity; Software project management: cost estimation, project scheduling, risk management, quality assurance, project monitoring; Estimation techniques: size estimation- LOC estimation, function count, cost estimation, Halstead size estimation, Software design: analysis modeling, functional modeling, behavioral modeling; unified modeling language; Software architecture; Data design: data modeling, data structures; Software testing: white box (unit and integration), black box (system level, regression); Software maintenance: maintenances characteristics, maintainability, maintenances tasks, maintenances side effects; Current trends in software engineering.

References:

1. R. S. Pressman, *Software Engineering: A Practitioners Approach*, (8e), McGraw Hill, 2016.
2. I. Sommerville, *Software Engineering*, (10e), Pearson Education, 2016.
3. R. Mall, *Fundamental of Software Engineering*, (5e), Prentice Hall of India, 2018.

P. Jalote, *Software Engineering a Precise Approach*, (1e), Wiley, 2010.

CC3102: DESIGN AND ANALYSIS OF ALGORITHMS [3 1 0 4]

Algorithm analysis: a priori and a posteriori analysis, time space tradeoff, asymptotic notations, properties of asymptotic notations, recurrence equations, solving recurrence equations using substitution method and master's method; Divide and conquer: binary search, finding maximum and minimum, merge sort, quick sort, matrix multiplication; Greedy algorithms: knapsack problem, job sequencing with deadline, optimal merge pattern, single source shortest path, minimum cost spanning tree; Dynamic programming: multistage graphs, matrix chain multiplication, all-pair shortest paths, optimal binary search trees, 0/1 knapsack, travelling salesperson problem, graph traversals, connected components, spanning trees, bi-connected components; String matching algorithms; Complexity classes: introduction to NP-hard and NP completeness; Approximation algorithm; Randomized algorithm.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to algorithms,* (3e), Prentice Hall of India, 2010.
2. E. Horowitz, S. Sahni, S. Rajasekaran, *Computer Algorithms,* (2e), University Press, 2017.
3. A. V. Aho, J. E. Hopcroft, J. D. Ullman, *The Design and Analysis of Computer Algorithms,* (1e), Pearson Education, 1999.
4. S. S. Skiena, *The Algorithm Design Manual,* (2e), Springer, 2010.

CC3103: FOUNDATIONS OF DATA SCIENCE [3 1 0 4]

Basics of Data Science: Introduction, Typology of problems, Importance of linear algebra, statistics and optimization from a data science perspective, Structured thinking for solving data science problems; Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.), Eigenvalues and eigenvectors, Matrix factorizations, Inner products, Distance measures, Projections, Notion of hyper planes, half-planes; Probability, Statistics and Random Processes: Probability theory and axioms, Random variables, Probability distributions and density functions (univariate and multivariate), Expectations and moments, Covariance and correlation, Statistics and sampling distributions, Hypothesis testing of means, proportions, variances and correlations, Confidence (statistical) intervals, Correlation functions, White-noise process; Optimization: Unconstrained optimization, Necessary and sufficiency conditions for optima, Gradient descent methods, Constrained optimization, KKT conditions, Introduction to non-gradient techniques, Introduction to least squares optimization, Optimization view of machine learning; Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem, Linear classification problems.

References:

1. G. Strang, *Introduction to linear algebra*, Wellesley, (5e), MA: Wellesley-Cambridge Press, 2016.
2. J. S. Bendat, A. G. Piersol, *Random data: analysis and measurement procedures*, (4e), John Wiley & Sons. 2010.
3. D. C. Montgomery, G. C. Runger, *Applied statistics and probability for engineers*, (5e), John Wiley & Sons, 2011.
4. C. O'Neil, R. Schutt, *Doing data science: Straight talk from the frontline*, O'Reilly Media, Inc., 2016.

CC3104: CRYPTOGRAPHY AND SECURITY [3 1 0 4]

Introduction: confidentiality, integrity, availability, OSI security architecture; Number theory: finite fields, Galois field, primes, primality testing, factoring algorithms; Probability and information theory: Shannon's theory, perfect security; Classical ciphers; Block ciphers: DES, AES, electronic codebook mode, cipher block chaining mode, cipher feedback mode, output feedback mode, counter mode; Pseudorandom number generation; Stream ciphers; Cryptographic hash functions; Message authentication codes; Public-key cryptography: computational security, computational assumptions**,** RSA, ElGamal, elliptic curve cryptography**,** digital signatures, Diffie-Hellman key exchange; Operating systems security: security capabilities of different platforms, identification, authentication, user accounts, file permissions, backups, access control, firewalls, methods of protection, ownership, assessing and securing a system, information warfare, security administration, corporate espionage.

References:

1. W. Stallings, *Cryptography and Network Security-Principles and Practice*, (7e), Pearson Education, 2017.
2. B. A. Forouzan, D. Mukhopadhyay, *Cryptography And Network Security*, (3e), McGraw Hill, 2015.
3. D. Stinson, *Cryptography: Theory and Practice*, (4e), CRC Press, 2018.
4. J. Pieprzyk, T. Hardjono, J. Seberry, *Fundamentals of Computer Security*, (1e), Springer-Verlag Berlin Heidelberg, 2013.
5. C. P. Pfleeger, S. L. Pfleeger, J. Margulies, *Security in Computing*, (5e), Pearson Education, 2018.

CC3130: SOFTWARE ENGINEERING LAB [0 0 2 1]

Development of software requirements specification (SRS); Use of appropriate CASE tools and other tools such as configuration management tools, program analysis tools in the software life cycle; Flow of events and System

modelling (DFD and ER); Use Case diagrams; Object-oriented design using UML; Class diagram; Object diagram; State transition diagram, State chart diagram; activity diagram; Sequence diagram; Collaboration diagrams; Component diagram; Deployment diagram; Designing test cases for white box and black box testing strategies; Introduction to DevOps; Mini project.

References:

1. R. S. Pressman, *Software Engineering: A Practitioners Approach*, (7e), McGraw Hill, 2016.
2. I. Sommerville, *Software Engineering*, (10e), Pearson, 2016.
3. R. Mall, *Fundamental of Software Engineering*, (5e), PHI, 2018.
4. P. Jalote, *Software Engineering a Precise Approach*, (1e), Wiley India, 2010.
5. L. Bass, *DevOps: A Software Architect's Perspective*, Pearson Education, 2016.

CC3131: DESIGN AND ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Implement a doubly linked list & BST, GCD Techniques, Bubble sort, Selection sort, Linear search, String Matching, sorting algorithms, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to algorithms,* (3e), Prentice Hall of India, 2010.
2. E. Horowitz, S. Sahni, S. Rajasekaran, *Computer Algorithms,* (2e), University Press, 2017.
3. A. V. Aho, J. E. Hopcroft, J. D. Ullman, *The Design and Analysis of Computer Algorithms,* (1e), Pearson Education, 1999.
4. S. S. Skiena, *The Algorithm Design Manual,* (2e), Springer, 2010.

SIXTH SEMESTER

BB0026: Organization and MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, C. O'Donnell, H. Weihrich, *Essentials of Management*, (1e), McGraw Hill, 1978.
2. Robbins, P. Stephen, M. Coulter, *Management,* (2e), Prentice Hall of India, 1997.
3. E. S. Buffa, R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987.
4. H. J. Arnold, D. C. Feldman, *Organizational Behavior*, McGraw Hill, 1986.
5. K. Aswathappa , *Human Resource and Personnel Management*, McGraw Hill, 2005.
6. W. William, D. Keith , *Human Resource and Personnel Management*, McGraw Hill, 1986.

CC3201: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING [3 1 0 4]

Artificial intelligence concepts: state space representation and search; Heuristic search techniques: hill climbing, best first search, AX, AOX, constraint satisfaction; Knowledge representation and reasoning; Formal logic and unification algorithms; Planning algorithms, goal stack planning, nonlinear planning using constraint posting, hierarchical planning; Case based reasoning; Optimization algorithms, genetic algorithm, ant colony optimization, particle swarm

optimization, simulated annealing; Supervised machine learning algorithms: classification algorithms – KNN, decision tree, naïve bayes, support vector machine, regression, random forests; Un-supervised machine learning algorithms: principal component analysis, k-means; Machine learning performance evaluation metrics: classification accuracy, logarithmic loss, confusion matrix, area under curve, F1 score, mean absolute error, mean squared error.

References:

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, (3e), Pearson Education, 2015.
2. T. M. Mitchell, Machine Learning, (1e), McGraw Hill, 1997.
3. D. Simon, Evolutionary optimization algorithms, (1e), Wiley, 2013.
4. D. Khemani, A First Course in Artificial Intelligence, (1e), McGraw Hill, 2015.
5. O. Richard, E. D. Peter, D. Hart, G. Stork, Pattern Classification, (2e), John Wiley, 2002.
6. C. Bishop, Pattern Recognition and Machine Learning, (1e), Springer, 2006.

CC3202: WIRELESS COMMUNICATIONS [3 0 1 4]

Introduction to Wireless Communications, Types of Wireless Services, Requirements for the Wireless services, Multipath propagation, Parameters of mobile multipath channels, Spectrum Limitations, Principles of Cellular networks, Multiple Access Schemes, Path Loss models, Signal Fading. Wireless Transceivers, Structure of a wireless communication link, Modulation and demodulation Schemes, Signal Processing in Wireless Systems, Principle of Diversity, Equalizers- Linear and Decision Feedback equalizers, Review of Channel coding and Speech coding techniques. Cellular Communications: 1G, 2G, 3G / LTE, 4G / LTE-A, 5G; New air interface and radio access virtualization.

References:

1. T. S. Rappaport, *Wireless Communications - Principle and Practice*, (2e), Prentice Hall of India, 2012.
2. A. F. Molisch, *Wireless Communications*, (2e), Wiley, 2011.
3. D. P. Agrawal, .A. Zeng, *Introduction to Wireless and Mobile Systems*, (3e), Thomson Press , 2012.

CC3203: AUTOMATA THEORY AND COMPILER DESIGN [3 0 0 3]

Introduction to abstract models of computers: Chomsky hierarchy; regular languages: deterministic finite automata (DFA) and nondeterministic finite automata (NFA), their equivalence, minimizing FA, regular expressions, identifying non-regular languages; Context-Free languages (CFLs): Context-Free grammars, push down automata (PDA), nondeterministic PDA and CFLs, deterministic PDA and CFLs; Introduction to Turing machine; Introduction to compiler design: lexical analysis, recognition of tokens, lexeme and patterns; Syntax analysis: LL(1) parsing, SLR parsers, LR parsers, LALR parsers, parser generators (Flex and Bison), parsing and ambiguity; Runtime environments.

References:

1. M. Sipser, *Introduction to the Theory of Computation*, (3e), Cengage Learning, 2012.
2. P. Linz, *An Introduction to Formal Languages and Automata*, (6e), Jones & Bartlett Learning, 2016.
3. J.E. Hopcroft, R. Motwani, J.D. Ullman, *Introduction to Automata Theory, Languages and Computation: For VTU*, (3e), Pearson Education, 2013.
4. J. Martin, *Introduction to Languages and the Theory of Computation*, (4e), McGraw Hill, 2010.
5. A.V. Aho, M.S. Lam, R. Sethi, J.D. Ullman, *Compiler Design: Principles, Techniques and Tools*, (2e), Prentice Hall of India, 2006.

CC3230: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB [0 0 2 1]

Implementation and/or use of libraries for application of algorithms: KNN, decision tree, naïve bayes, support vector machine, regression, random forests, logistic regression, cross validation, principal component analysis, k-means; Performance evaluation metrics: classification accuracy, logarithmic loss, confusion matrix, area under curve, F1 score, mean absolute error, mean squared error.

Frameworks: Python

References:

1. A. Geron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, (1e), O'Reilly, 2017.
2. S. Raschka, V. Mirjalili, Python Machine Learning, (2e), Packt Publishing, 2015.

3. W. Richert, L. P. Coelho, Building Machine Learning Systems with Python, (3e), Packet Publishing Ltd., 2013.
4. P. Harrington, Machine Learning in Action, (1e), Manning Publications Co., 2008.
5. S. Marsland, Machine Learning: An Algorithmic Perspective, (1e), Chapman & Hall/Crc, 2009.

CC3231: LINUX SHELL PROGRAMMING LAB [0 0 2 1]

General Unix Commands: Cal, date, echo, who, bc, script, passwd, who; File System & File Compression: file handling commands such as cat, cp, rm, mv, more, wc, cmp, diff, gzip, unzip, tar, zip, unzip, mkdir, rmdir, pwd, cd, File attribute: ownerships, permissions; The Process Basics, ps, Internal and external commands, Process states and zombies, nice, at, mesg, cron, time, top. VI Editor: The vi editor Basics, Input mode and The ex mode, Navigation, Editing text, I/O redirection, piping data. Regular Expressions: The period (.), dollar ($), caret(^), asterisk(X). cut, paste, sed, grep, sort, uniq. Shell and Shell programming: The Shell's interpretive cycle, Shell offering, Pattern Matching, Parameter substitution. Decisions: test: string, integer, file and logical operators, else, exit, elif and case. Loops: For, while until. Breaking out from loop, Executing loop in background. Reading and printing data: read, program to copy files, mycp, printf commands. Network Commands: Telnet, ipconfig, ping, netstat, firewalls, System configurations.

References:

1. P. Wood, S. G. Kochan, *Shell Programming in Unix, Linux and OS X*, (4e), Addison-Wesley Professional, 2016.
2. S. Das, *Unix Concepts and Applications*, (4e), McGraw Hill, 2006.
3. W. R. Stevens, S. A. Rago, *Advanced Programming in the UNIX Environment*, (3e), Addison-Wesley, 2013.

CC3270: Minor Project [0 0 6 3]

Prerequisites: RDBMS/ Programming Languages/Web Technologies

In this practical course, each group consisting of two/three members is expected to design and develop practical solutions to real life problems related to Industry, institutions and computer science research. Software life cycle should be followed during the development. The theoretical knowledge, principles and practices gained from various subjects would be applied to develop effective solutions to various computing problems. The knowledge gained to work with various software tools, Designing tools, programming languages, operating systems, etc. would be utilized in various stages of project. Structured/ Object Oriented design techniques may be used for the project. Software Requirements Specification (SRS), Modeling Techniques, Design and Testing strategies would be part of document of the work. A committee consisting of minimum three faculty members shall perform internal assessment of the minor projects. A report on minor project would be submitted for evaluation, Project work would be presented and demonstrated before the panel of examiners.

SEVENTH SEMESTER

CC4170: INDUSTRIAL TRAINING [0 0 2 1]

In this course, student needs to undergo training in reputed institute of Private Sector / Public Sector / Government-organization / Companies / Industry / Academia / Research for duration of 4-6 weeks in the summer vacation after VI semester.To promote cooperation and to develop synergetic collaboration between Industry & University in promoting a knowledgeable society and to set the stage for future recruitment by potential employers.

EIGHTH SEMESTER

CC4270: MAJOR PROJECT

In this course, student needs to work on a project based on a topic of interest. Periodically, the supervisor will evaluate the progress. This work will start in VIII semester, and will be evaluated internally and externally. Investigating professional topics related to computing projects.The aim is to Design and develop the software with software engineering practices and standards.Apply knowledge to design and implement solutions for computational problems while considering numerous realistic constraints.Solve real world problems and contribute to open community with ethical values by undergoing systematic study and to communicate the proposed solution.Work in team with proper contribution from individuals and managing the project with lifelong learning.

PROGRAM ELECTIVES -II, III, IV

CC3140: WEB PROGRAMMING [3 0 0 3]

Introduction: overview of internet and "the web", web system architecture; HTTP: basics of HTTP request and response, HTTP methods, headers, content transport (push and pull), drawbacks HTTP1.0, introduction to HTTP1.1, HTTPS, SSL; Client side programming: introduction to HTML, using XHTML – basic syntax and semantics, fundamental elements, URLs – inter-page and intra-page linking, lists, tables, frames and forms, html document object model (DOM), deficiencies of HTML, introduction to HTML5, styling with CSS4, CSS5; JavaScript: fundamental, document object model, event handling, pattern matching and form validation with regular expressions, internal & external JavaScript, working with class, objects, constructors and inheritance, JSON; Server side programming: three tier model, PHP –basics, form validation, sessions and session tracking techniques, ASP; XML: syntax and semantics, document structure, DTDs; Angular JS: overview, MVC architecture, directives, controllers, modules; Node JS: modules, NPM modules, create, edit and publish NPM modules.

References:

1. D. Herron, *Node.js Web Development: Server-side development with Node 10 made easy*, (4e), Packet Publishing, 2018.
2. S. Seshadri, *Angular: Up and Running- Learning Angular, Step by Step*, (1e), Shroff/O'Reilly, 2018.
3. DT. E. Services, *HTML 5 Black Book*, (2e), Dreamtech Press, 2016.
4. J. Sklar, *Web Design Principles*, (5e), Cengage, 2015.
5. P. J. Deitel, H. M. Deitel, *Internet and World Wide Web How to program*, (5e), Pearson, 2011.
6. B. M. Harwani, *Developing Web Applications in PHP and AJAX*, (1e), McGraw Hill, 2010.
7. R. Moseley, M. T. Savaliya, *Developing Web Applications*, (1e), John Wiley & Sons, 2007.
8. J. C. Jackson, *Web Technologies: A Computer Science Perspective*, Pearson Education, 2007.

CC3141: SOFT COMPUTING [3 0 0 3]

Introduction: Soft computing and its applications; Neural networks: Architectures, Transfer Functions; Learning models: supervised, unsupervised, reinforcement learning; Types of neural network: perceptron, backpropagation, multi-layer perceptron, radial basis function, recurrent neural network, self-organizing maps, Boltzmann machine; Fuzzy logic and fuzzy systems: introduction and applications, fuzzy versus crisp set, basic operations on fuzzy sets, relations, fuzzy rule based models, fuzzy classification, fuzzy arithmetic, fuzzy numbers, linguistic variables, arithmetic operations on intervals and numbers, lattice of fuzzy numbers, fuzzy equations, properties of membership functions, fuzzification and defuzzification, automated methods for fuzzy systems; Genetic algorithms: overview, applications, operators, fitness function, classifier systems, convergence; Hybrid soft computing approaches.

References:

1. S.N. Sivanandam, S.N. Deepa, *Principles of Soft Computing,* (3e), Wiley, 2018.
2. T. J. Ross, *Fuzzy Logic with Engineering Applications*, (2e), Wiley, 2016.
3. S. J. Russel, P. Norvig, *Artificial Intelligence,* (3e), Pearson, 2015.
4. J. –S Jang, R, C. – T Sun, E. Mizutani, *Neuro-fuzzy and Soft Computing*, Pearson, 2015.
5. G. J. Klir, B. Yuan, *Fuzzy Sets & Fuzzy Logic - Theory and Applications*, (2e), Prentice Hall, 2015.
6. M. T. Hagen, H. B. Demuth, M. H. Beale, O. D. Jesus, *Neural Network Design*, (2e), Cengage, 2014.
7. S. Roy, U. Chakraborty, *Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms*, Pearson, 2013.

CC3142: DIGITAL COMMUNICATION and SIGNAL PROCESSING [3 0 0 3]

Introduction to signal and systems: signal presentation, signal classification, signal analysis, Fourier series, Fourier transform, Z-transform, classification of systems, system properties - memory, linearity, causality, invertibility, time invariance and stability, Linear-Time-Invariant (LTI) systems. Pulse modulation systems: PAM, PCM, delta modulation, baseband digital data transmission, Inter Symbol Interference (ISI), Nyquist condition, optimum detection, noise probability of error expression. Digital modulation techniques: ASK, PSK, DPSK, FSK, QAM, QPSK, OQPSK, MSK, GMSK and OFDM. Information theory and coding: Information rate and Shannon-Fano coding, Huffman coding, Shannon's theorem and channel capacity.

References:

1. B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication*, (5e), Oxford University Press, 2018.

2. S. Haykin, *Digital Communications*, (2e), John Wiley and Sons, 2013.
3. H. Taub, D. L. Schilling and G. Saha, *Principles of Communication Systems*, (2e), McGraw Hill, 2017.
4. H. P. Hsu, *Analog and Digital Communications*, (3e), Schaum's outline series, 2017.
5. J. G. Proakis, *Digital Communications*, (5e), McGraw Hill, 2014.

CC3240: ADVANCED INTERNET TECHNOLOGIES [3 0 0 3]

Introduction: web design fundamentals, website strategy and planning, AJAX, web sockets; Client side technologies: client side architecture, XHTML, CSS, JavaScript, generation and session tracking techniques on client-side; XML: XML basics, DTD, XSLT, xml DOM; jQuery: jQuery introduction, jQuery events, jQuery effects, jQuery hide/show, jQuery animate, jQuery call-back, jQuery chaining, jQuery HTML, jQuery Get, jQuery set, add, remove, filtering, AJAX, Get/Post; PHP: variables and constants, strings, regular expressions, operators, conditional statements, looping statements, functions, arrays, PHP forms, cookies, PHP sessions, Introduction to OOP, database connection and various operation; Bootstrap: BS grid basic, BS typography, BS tables, BS images, BS badges/labels, BS progress bars, BS pagination, BS pager, BS groups, BS panels, BS dropdowns; Node.js: introduction, modules, HTTP module, file system, NPM, events, Email, MySQL; Angular 4: ES6, typescript, angular-CLI and angular components, providers, dependency injection, observables, angular modules, directives and pipes; Web/Application/Database servers: structure, architecture of web servers with working (IIS , Apache), installation and configuration of web servers, security aspects, deployment of web pages, maintenance and monitoring of web pages.

References:

1. D. Goldberg, *Internet and World Wide Web - How to Program*, (5e), Pearson, 2011.
2. R. Nixon, *Learning PHP, MySQL & JavaScript*, (5e), O'Reilly Media, 2019.
3. D. Flanagan, *jQuery Pocket Reference: Read Less, Learn More*, (1e), O'Reilly Media, 2019.
4. S. Seshadri, *Angular: Up and Running: Learning Angular, Step by Step,* O'Reilly Media, 2018.
5. J. Spurlock, *Bootstrap: Responsive Web Development, (1e),* O'Reilly Media, 2013.

CC3241: COMPUTER VISION [3 0 0 3]

Image formation and image models: cameras, geometric camera models, geometric camera calibration, radiometry measuring light, sources, and shading; Color early vision - single image: linear filters, edge detection; Texture early vision - multiple images: the geometry of multiple views, stereopsis, affine structure from motion, projective structure from motion; Mid-level vision: segmentation by clustering, segmentation by fitting a model, segmentation and fitting using probabilistic methods, tracking with linear; Dynamic models high-level vision: geometric methods: smooth surfaces and their outlines, aspect graphs, range data; High-level vision: probabilistic and Inferential methods, finding templates using classifiers, recognition by relations between templates, geometric templates from spatial relations.

References:

1. D. A. Forsyth, J. Ponce, *Computer Vision: A Modern Approach*, (2e), Pearson Education, 2008.
2. R. Hartley, A. Zisserman, *Multiple View Geometry in Computer Vision*, (2e), Cambridge University Press, 2004.
3. R. Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2011.
4. J. Leskovec, A. Rajaraman, J. D. Ullman, *Mining of massive dataset*, (2e), Cambridge university press, 2014

CC3242: NEXT GENERATION TELECOM NETWORKS [3 0 0 3]

Introduction to 1G/2G/3G/4G/5G terminology; evolution of public mobile services; Motivation for IP based wireless networks: requirements and targets for long term evolution (LTE); Technologies for LTE- 4G advanced features and roadmap evolutions from LTE to LTEA - wireless standards; Review of cellular technologies; Wireless next generation technologies; Next generation networks; GSM technology; Introduction to next generation networks (NGN); Broadband wireline and wireless alternatives; Wireless access technologies; Overview of TCP/IP and packet core; Advanced IP networking; Overview of voice and video transport over IP; NGN requirements; Architecture and protocols; Next generation network and service management; NGN architectural components; NGN standards and protocols; NGN applications and architecture; SATCOM and broadband wireless architecture; NGN operations and management; Understand 5GPP & NGMN; 5G architecture and design objective; ITU-R IMT-2020 vision for 5G; 5G spectrum requirements; 5G RAN & dynamic CRAN; 5G NR logical architecture; 5G mobile edge computing & fog

computing; millimeter wave propagation; Distributed massive MIMO principle; 5G ultra dense networks; 5G CoMP; 5G air interface; 5G protocol stack.

References:

1. N. Wilkinson, *Next Generation Networks Services, Technologies and Strategies*, (1e), Wiley, 2002.
2. R. Wood, *Next Generation Network Services*, Pearson Education, 2005.
3. S. Misra, *Wireless Communication and Networks 3G and beyond*, (2e), McGraw Hill, 2013.
4. K. Pahlavan, P. Krishnamurthy, *Principle of wireless Networks*, Pearson Education, 2002.
5. Dulaimi, X. Wang, C.Lin, *5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management*, (1e), John Wiley & Sons, 2018.
6. T. V. Chien, E. Björnson, *5G Mobile Communications*, Springer, 2017.

CC4140: PRINCIPLES OF WEB SERVICES [3 0 0 3]

Evolution and emergence of web services: emergence of web services and Service Oriented Architecture (SOA), introduction to web services –model of web services, tools and technologies enabling web services, benefits and challenges of using web services; Web service architecture: characteristics, web services communication, WSDL, brief over view of XML; SOA design implementation, managing SOA environment: service-oriented design process, design activities, determine services and tasks based on business process model, implementing SOA; SOAP(Simple Object Access Protocol): SOAP as a messaging protocol, UDDI architecture and implementation, UDDI with WSDL, UDDI specification; REST(Representational State Transfer): messages, HTTP request and format, HTTP response and format, query parameters, protocol semantics of HTTP(GET, PUT, POST, DELETE, HEAD, OPTIONS, TRACE) , REST vs SOAP.

References:

1. R. Skoczylas, R.P. Sriganesh, *Developing Java Web Services*, (2e), Wiley India, 2008.
2. S. Chatterjee, J. Webber, *Developing Enterprise Web Services*, (2e), Pearson, 2003.
3. Coyle, F. Paul, *XML, Web services, and the data revolution*, (1e), Addison-Wesley,2008.
4. S. Graham, *Building web Services with Java*, (2e), Pearson, 2004.
5. B. M. Balachandar, *RESTful Java Web Services*, (3e), Packt Publishing Limited, 2017.
6. E. Cerami, *Web Services Essentials: Distributed Application with XML – RPC, SOAP, UDDI & WSDL*, (1e), O' Reilly, 2002.
7. M. Papazoglou, *Web Services and SOA: Principles and Technology,* (2e), Pearson, 2008.

CC4141: DEVOPS FUNDAMENTALS [3 0 0 3]

Introduction: overview of DevOps, market trends, skills, delivery pipeline, ecosystem; Version Control: concept of Git, common commands, working with remote repositories; Continuous Integration (CI): branching and merging in Git, workflows, Git cheat sheet, introduction to Jenkins, Jenkins management, adding a slave node to Jenkins, building delivery pipeline, pipeline as a code, introduction to Maven; Continuous Testing (CT): need, Selenium and Webdriver, creating test cases, handling different controls on webpage, frameworks; Continuous Deployment: introduction to container, life cycle, sharing and copying, understanding images and containers, working with docker, publishing image; Docker ecosystem, compose, Swarm, managing and running containers, Docker networking, network types, Kubernetes; Continuous Deployment (Configuration Management (CM)): Puppet installation and configuration, master and agent setup, puppet module, node classification, puppet environment and classes, automation and reporting; Ansible: installation and configuring, roles, write playbooks; Continuous Monitoring: Nagios installing, Plugins(NRPE) and objects, Nagios commands and notification; DevOps on Cloud: introduction to cloud computing, why DevOps on cloud, Introduction to AWS, various AWS services, DevOps using AWS.

References:

1. L. Bass, *DevOps: A Software Architect's Perspective*, Pearson Education, 2016.
2. N. Felson, *Effective DevOps with AWS*, Packet Publishing Limited, 2017.
3. J. Davis, R. Daniels, *Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale*, O'Reilly Media 2016.

CC4142: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Introduction: Natural language processing tasks in syntax, semantics, and pragmatics, role of machine learning, probability basics, information theory, collocations, N-gram language models, estimating parameters and smoothing, evaluating language models; Part of Speech (POS) tagging: Rule-based Part of Speech tagging, Markov models, Hidden Markov Models, transformation based models, maximum entropy models; Parsing: Parsing algorithms, grammar formalisms and treebanks, parsing with context free grammars, parser comparison, constituency, parse tree construction; Semantic analysis: Word-sense disambiguation, supervised, dictionary based and unsupervised approaches, compositional semantics, semantic role labeling and semantic parsing; Machine translation: Basic issues, statistical translation, phrase-based translation, phonetics and phonology.

References:

1. D. Jurafsky, J. H. Martin, *Speech and Language processing*, (3e), Prentice Hall of India, 2018.
2. J. Allen, *Natural Language Understanding*, (2e), Pearson Education, 2002.
3. C. D. Manning, H. Schuetze*, Foundations of Statistical Natural Language Processing*, (1e), MIT Press, 1999.
4. S. Bird, E. Klein, E. Loper, *Natural Language Processing with Python*, (1e) O'Reilly Media, 2009.
5. R. Hausser*, Foundations of Computational Linguistics: Human- Computer Communication in Natural Language*, (2e), Springer, 2012.

CC4143: DEEP LEARNING [3 0 0 3]

Introduction: Neural networks; Training a network: Loss functions, back propagation and stochastic gradient descent, neural networks as universal function; Convolutional Neural Networks: Introduction to Convnet, training a Convnet, weights initialization, batch normalization, pooling, padding, dropouts, hyper parameter optimization, CNN Architectures- AlexNet, VGG, Inception, ResNet; Recurrent neural network: Recurrent networks, long short-term memory(LSTM), gated recurrent units(GRU), recurrent neural network language models; Deep unsupervised learning: Auto encoders, variation auto encoders, generative adversarial networks(GAN), maximum entropy distributions; Applications: Deep learning applications to computer vision and natural language processing(NLP).

References:

1. Deng & D. Yu, *Deep Learning: Methods and Applications*, (1e), Now Publishers, 2014.
2. Goodfellow, Y. Bengio, A. Courville, *Deep Learning*, (1e), MIT Press, 2016.
3. M. Nielsen, *Neural Networks and Deep Learning*, (1e), Determination Press, 2015.
4. C. R. Shalizi, *Advanced Data Analysis from an Elementary Point of View*, (1e) Cambridge University Press, 2015.

CC4144: Internet of Things (IoT) [3 0 0 3]

Introduction to Internet of Things: Definition & Characteristics of IoT; Physical Design of IoT; Logical Design of IoT: Functional Blocks, Communication Models, Communication APIs; IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems; IoT Levels: Level-1, Level-2, Level-3, Level-4, Level-5; IoT and M2M: Difference between IoT and M2M, SDN and NFV for IoT; IoT Platforms Design Methodology: Purpose & Requirements Specifications, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device & Component Integration; IoT Physical Devices & Endpoints: Basic building blocks of an IoT Device, Raspberry Pi, pcDuino, BeagleBone Black, Cubieboard; IoT Physical Servers & Cloud Offerings: Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT, Xively Cloud for IoT, Django Architecture, Amazon Web Services for IoT, Amazon EC2, Amazon AutoScaling, Amazon S3, Amazon RDS, Amazon DynamoDB, Amazon Kinesis, Amazon SQS, Amazon EMR, SkyNet IoT Messaging Platform; Security issues in IoT based applications and approaches. Domain Specific IoTs (such as Home Automation, Smart Cities, Smart Environment, Smart Energy, Retail, Logistics, Agriculture, IIoT);

References:

1. A. Bahga, V. Madisetti, *Internet of Things: A Hands-On Approach*, (1e), Universities Press (India) Private Limited, 2014.
2. R. Pethuru, A. C. Raman, *The Internet of Things: Enabling Technologies*, Platforms, and Use Cases, CRC Press, 2017.
3. A. McEwen, H. Cassimally, *Designing the Internet of Things*, (2e), Wiley, 2014.
4. R. Kamal*, Internet of Things – Architecture and Design Principles*, (1e), McGraw Hill, 2017.

CC4141: DEVOPS FUNDAMENTALS [3 0 0 3]

Introduction: overview of DevOps, market trends, skills, delivery pipeline, ecosystem; Version Control: concept of Git, common commands, working with remote repositories; Continuous Integration (CI): branching and merging in Git, workflows, Git cheat sheet, introduction to Jenkins, Jenkins management, adding a slave node to Jenkins, building delivery pipeline, pipeline as a code, introduction to Maven; Continuous Testing (CT): need, Selenium and Webdriver, creating test cases, handling different controls on webpage, frameworks; Continuous Deployment: introduction to container, life cycle, sharing and copying, understanding images and containers, working with docker, publishing image; Docker ecosystem, compose, Swarm, managing and running containers, Docker networking, network types, Kubernetes; Continuous Deployment (Configuration Management (CM)): Puppet installation and configuration, master and agent setup, puppet module, node classification, puppet environment and classes, automation and reporting; Ansible: installation and configuring, roles, write playbooks; Continuous Monitoring: Nagios installing, Plugins(NRPE) and objects, Nagios commands and notification; DevOps on Cloud: introduction to cloud computing, why DevOps on cloud, Introduction to AWS, various AWS services, DevOps using AWS.

References:

1. L. Bass, *DevOps: A Software Architect's Perspective*, Pearson Education, 2016.
2. N. Felson, *Effective DevOps with AWS*, Packet Publishing Limited, 2017.
3. J. Davis, R. Daniels, *Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale*, O'Reilly Media 2016.

CC4142: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Introduction: Natural language processing tasks in syntax, semantics, and pragmatics, role of machine learning, probability basics, information theory, collocations, N-gram language models, estimating parameters and smoothing, evaluating language models; Part of Speech (POS) tagging: Rule-based Part of Speech tagging, Markov models, Hidden Markov Models, transformation based models, maximum entropy models; Parsing: Parsing algorithms, grammar formalisms and treebanks, parsing with context free grammars, parser comparison, constituency, parse tree construction; Semantic analysis: Word-sense disambiguation, supervised, dictionary based and unsupervised approaches, compositional semantics, semantic role labeling and semantic parsing; Machine translation: Basic issues, statistical translation, phrase-based translation, phonetics and phonology.

References:

1. D. Jurafsky, J. H. Martin, *Speech and Language processing*, (3e), Prentice Hall of India, 2018.
2. J. Allen, *Natural Language Understanding*, (2e), Pearson Education, 2002.
3. C. D. Manning, H. Schuetze*, Foundations of Statistical Natural Language Processing*, (1e), MIT Press, 1999.
4. S. Bird, E. Klein, E. Loper, *Natural Language Processing with Python*, (1e) O'Reilly Media, 2009.
5. R. Hausser*, Foundations of Computational Linguistics: Human- Computer Communication in Natural Language*, (2e), Springer, 2012.

CC4143: DEEP LEARNING [3 0 0 3]

Introduction: Neural networks; Training a network: Loss functions, back propagation and stochastic gradient descent, neural networks as universal function; Convolutional Neural Networks: Introduction to Convnet, training a Convnet, weights initialization, batch normalization, pooling, padding, dropouts, hyper parameter optimization, CNN Architectures- AlexNet, VGG, Inception, ResNet; Recurrent neural network: Recurrent networks, long short-term memory(LSTM), gated recurrent units(GRU), recurrent neural network language models; Deep unsupervised learning: Auto encoders, variation auto encoders, generative adversarial networks(GAN), maximum entropy distributions; Applications: Deep learning applications to computer vision and natural language processing(NLP).

References:

1. L. Deng & D. Yu, *Deep Learning: Methods and Applications*, (1e), Now Publishers, 2014.
2. Goodfellow, Y. Bengio, A. Courville, *Deep Learning*, (1e), MIT Press, 2016.
3. M. Nielsen, *Neural Networks and Deep Learning*, (1e), Determination Press, 2015.
4. C. R. Shalizi, *Advanced Data Analysis from an Elementary Point of View*, (1e) Cambridge University Press, 2015.

CC4144: Internet of Things (IoT) [3 0 0 3]

Introduction to Internet of Things: Definition & Characteristics of IoT; Physical Design of IoT; Logical Design of IoT: Functional Blocks, Communication Models, Communication APIs; IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems; IoT Levels: Level-1, Level-2, Level-3, Level-4, Level-5; IoT and M2M: Difference between IoT and M2M, SDN and NFV for IoT; IoT Platforms Design Methodology: Purpose & Requirements Specifications, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device & Component Integration; IoT Physical Devices & Endpoints: Basic building blocks of an IoT Device, Raspberry Pi, pcDuino, BeagleBone Black, Cubieboard; IoT Physical Servers & Cloud Offerings: Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT, Xively Cloud for IoT, Django Architecture, Amazon Web Services for IoT, Amazon EC2, Amazon AutoScaling, Amazon S3, Amazon RDS, Amazon DynamoDB, Amazon Kinesis, Amazon SQS, Amazon EMR, SkyNet IoT Messaging Platform; Security issues in IoT based applications and approaches. Domain Specific IoTs (such as Home Automation, Smart Cities, Smart Environment, Smart Energy, Retail, Logistics, Agriculture, IIoT);

References:

1. A. Bahga, V. Madisetti, *Internet of Things: A Hands-On Approach*, (1e), Universities Press (India) Private Limited, 2014.
2. R. Pethuru, A. C. Raman, *The Internet of Things: Enabling Technologies*, Platforms, and Use Cases, CRC Press, 2017.
3. A. McEwen, H. Cassimally, *Designing the Internet of Things*, (2e), Wiley, 2014.
4. R. Kamal*, Internet of Things – Architecture and Design Principles*, (1e), McGraw Hill, 2017.

CC4145: SOFTWARE DEFINED NETWORKS [3 0 0 3]

History and Evolution of Software Defined Networking (SDN): Separation of Control Plane and Data Plane, IETF Forces, Active Networking. Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the OpenFlow protocol. Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Mininet based examples. Control Plane: Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hardware-based; Programmable Network Hardware. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications. Data Centre Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centres, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

References:

1. T. D. Nadeau, Ken Gray, *SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies*, (2e), O'Reilly Media, 2013.
2. P. Goransson, C. Black, M. Kaufmann*, Software Defined Networks: A Comprehensive Approach*, (2e), Morgan Kaufmann, 2014.
3. F. Hu, *Network Innovation through OpenFlow and SDN: Principles and Design*, (1e), CRC Press, 2014.

PROGRAM ELECTIVES- V, VI, VII

CC4146: Embedded Systems [3 0 0 3]

Introduction to embedded systems, with/without communication, chargeable and storage battery; Design and implementation: typical requirements and their representation, generation of specifications, executable specs, behavioural models, hardware software partitioning, embedded software synthesis, mapping of hardware to standard micros; Building blocks of embedded systems: RISC/CISC architectures, multicore, variants of micros, typical building blocks of micros; Memory: RAM, ROM, NVROM, flash memory, DDR, cache; Timers, PIC, ADC, DAC, MUX; Serial communication: USB, I^2C, CAN, SPI RF controllers, Bluetooth, ZigBee, WiFi, ethernet; Custom building blocks: TDC, FFT, DCT, FPGAs/PLDs; sensors and actuator, displays, low power modes, battery management; Programming of micros: IDEs, emulators, debuggers, instruction set emulators, MISRA, WELMEC; embedded system development using MATLAB and LabVIEW, low-end applications: custom manager; Kernels & RTOS: kernels,

Windows CE, embedded Linux, Android and iOS; embedding real time capabilities: RTK, RTOS, multi-tasking, task scheduler; Networked embedded systems: Wireless Sensor Networks and IoT, Case studies and projects.

References:

1. F. Vahid, T. Givargis, *Embedded System Design-A Unified Hardware/Software Introduction*, (3e), Wiley, 2009.
2. K. V. Shibu, *Introduction to Embedded Systems*, (2e), McGraw Hill, 2017.
3. D. E. Simon, *An Embedded Software Primer*, (1e), Pearson Education, 2014.
4. S. Heath, *Embedded System Design*, (2e), Elsevier, 2005.
5. J. K. Peckol, *Embedded Systems – A Contemporary Design Tool*, Wiley Student Edition, 2009.
6. J.W. Valvano, *Embedded Microcomputer Systems: Real Time Interfacing*, (3e), Cengage Learning, 2011.
7. M. Huth and M. Ryan, *Logic in Computer Science: Modeling and Reasoning about Systems*, (1e), Cambridge University Press, 2004.
8. Q. Li and C. Yao, *Real-time Concepts for Embedded Systems*, (1e), CRC Press, 2003.

CC4147: NETWORKS ON CHIP [3 0 0 3]

Introduction: advent of the multi-core, Communication demands of multi-core architectures, on-chip vs. off-chip networks; Network basics: a quick primer evolution to on-chip networks; Shared memory networks in chip multiprocessors: impact of coherence protocol; Design requirements for on-chip network: NoC synthesis, case studies; Routing: types of routing algorithms, deadlock avoidance, turn models; Logic based distributed routing; Selection methods; Flow control: basis units of flow control, different types of flow control, virtual channels deadlock-free flow control, escape VCs, buffer, backpressure; Router microarchitecture: virtual channel router microarchitecture, pipeline; Switch design: crossbar designs, crossbar speedup; Fault tolerance in router; Simulations of various strategies of on chip networks by varying different parameters.

References:

1. N. D. E. Jerger, T. Krishna, L.S. Peh, *On-chip Networks*, (2e), Morgan & Claypool, 2009.
2. M. Palesi, M. Daneshtalab, *Routing algorithms in networks-on-chip*, (1e), Springer, 2014.
3. W. J. Dally, B. P. Towels, *Principles and Practices of Interconnection Networks*, (2e), Morgan Kaufmann, 2004.
4. J. Duato, S. Yalamanchili, L. Ni, *Interconnection Networks: An Engineering Approach*, (2e), Morgan Kaufmann, 2003.

CC4148: WIRELESS SENSORs & AD-HOC NETWORKS [3 0 0 3]

Introduction to ad-hoc networks: definition, characteristics features, applications, characteristics of wireless channel; Ad-hoc mobility models: indoor and outdoor models, MAC protocols: design issues, goals and classification; Contention based protocols: with reservation, scheduling algorithms, protocols using directional antennas; IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, hiperlan; Routing protocols: design issues, goals and classification, proactive vs reactive routing, unicast routing algorithms, multicast routing algorithms, hybrid routing algorithm, energy aware routing algorithm, hierarchical Routing, QoS aware routing; Transport layer: issues in designing, transport layer classification, ad-hoc transport protocols; Security issues in ad-hoc networks: issues and challenges, network security attacks, secure routing protocols; Cross layer design: need for cross layer design, cross layer optimization, parameter optimization techniques, cross layer cautionary perspective; Integration of ad-hoc with mobile IP networks; Mesh networks; vehicular area networks; Ad-hoc networks: cellular and ad-hoc networks, routing, quality of service provisioning; Wireless sensor networks: design constraints and challenges, sensor network architecture; MAC protocols: Issues in designing MAC protocols for wireless sensor networks, MAC protocols for sensor network, S-MAC, IEEE 802.15.4; Routing protocols: table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols; QoS and energy management: Issues and challenges in providing QoS, need for energy management; Sensor network platforms and tools: sensor node hardware berkeley motes, programming challenges, node-level software platforms, node-level simulators.

References:

1. F. Zhao, L. J. Guibas, *Wireless Sensor Networks - An Information Processing Approach*, Elsevier, 2007.
2. H. Karl, A. Willig, *Protocols and Architectures for Wireless Sensor Networks*, John Wiley, 2005.
3. K. Sohraby, D. Minoli, T. Znati, *Wireless Sensor Networks- Technology, Protocols, and Applications*, John Wiley, 2007.

4. C. K. Toh, *Ad-Hoc Mobile Wireless Networks – Protocols and Systems*, (1e), Prentice Hall of India, 2001.
5. S. R. Murthy*, Ad-Hoc Wireless Networks - Architectures and Protocols*, (1e), Pearson Education, 2006.
6. Hac, *Wireless Sensor Network Designs*, (1e), John Wiley, 2003.

CC4149: HUMAN COMPUTER INTERACTION [3 0 0 3]

Foundations of HCI: The human: I/O channels, memory, reasoning and problem solving; The computer: devices, memory, processing and networks; Interaction: models, frameworks, ergonomics styles elements, interactivity, paradigms; Design & software process: interactive design basics, process, scenarios, navigation, screen design, iteration and prototyping; HCI in software process: software life cycle, usability engineering, prototyping in practice, design rationale; Design rules: principles, standards, guidelines, rules; Evaluation techniques, universal design; Models and Theories: cognitive models, socio-organizational issues and stake holder requirements, communication and collaboration models, hypertext, multimedia and www; Mobile HCI: mobile ecosystem, platforms, application frameworks, types of mobile applications: widgets, applications, games mobile information architecture, mobile 2.0; Mobile design: elements of mobile design, tools; Web interface design: designing web interfaces, drag & drop, direct selection, contextual tools, overlays, inlays and virtual pages, process flow; Case studies.

References:

1. Dix, J. E. Finlay, G .D. Abowd, R. Beale, *Human Computer Interaction,* (3e), Pearson Education, 2004.
2. S. Ben, P. Catherine, *Designing the user interface Strategies for effective human-computer interaction,* (5e), Pearson Education, 2014.
3. T.K. Prabhu, *Research methods in human computer interaction*, (2e), Oxford Book Company, 2017.
4. B. Fling, *Mobile Design and Development,* (1e), O'Reilly Media Inc., 2009.
5. C. David, *Linear Algebra and applications,* (3e), Pearson Education, 2009.

CC4150: MOBILE COMPUTING [3 0 0 3]

Evolution of mobile radio communication, Transmission fundamentals; Modulation techniques: Signal encoding criteria, Overview of ASK, PSK, FSK, MSK, Spread spectrum modulation; Wireless communication technologies: Cellular networks, Mobility in cellular based wireless network: handoff strategies, channel allocation, interferences, handoffs and location management. IP mobility: Mobile IP and IDMP, IEEE802.11, IEEE 802.11 Architecture and Services, Physical Layer and Medium Access Control, TCP/IP in mobile setting, Geolocation and Global Positioning System (GPS), Personal Area Network: Bluetooth and ZigBee, Mobile agent technology and standards.

References:

1. J.H. Schiller, *Mobile Communications*, Pearson Education, (2e), 2004.
2. R. Pandya, *Mobile and Personal Communication Systems and Services*, Prentice Hall of India, 2001.
3. R. B'Far, *Mobile Computing Principles*, (1e), Cambridge University Press, 2004.
4. T.S. Rappaport, *Wireless Communications - Principle and Practice*, (2e), Prentice Hall of India, 2005.
5. W. Stallings, *Wireless Communication and Network*, (2e), Prentice Hall of India, 2004.

CC4151: INFORMATION RETRIEVAL [3 0 0 3]

Basic concepts of IR: data retrieval and information retrieval, IR system block diagram, automatic text analysis, Luhn's ideas, conflation algorithm, indexing and index term weighing, probabilistic indexing, automatic classification. measures of association, different matching coefficient, classification methods, cluster hypothesis, clustering algorithms, single pass algorithm, single link algorithm, Rochhio's algorithm and dendograms; Distributed and Parallel IR: relationships between documents, identify appropriate networked collections, multiple distributed collections simultaneously, parallel MIMD architectures, distributed IR – collection partitioning, source selection, query processing, file structures, inverted file, suffix trees and suffix arrays, signature files, ring structure, IR models, basic concepts, Boolean model, vector model; Fuzzy set model: search strategies, Boolean search, serial search, and cluster based retrieval, matching function.

References:

1. C.D. Manning, P. Raghavan, H. Schuetze, *Introduction to Information Retrieval*, (1e), Cambridge University Press, 2007.
2. B.Croft, D.Metzler, T. Strohman *Search Engines: Information Retrieval in Practice*, (1e), Pearson Education, 2009.
3. B. Ricardo, B.Neto *Modern Information Retrieval*, (2e), Addison-Wesley, 2011.

CC4152: COMPUTER GRAPHICS AND MULTIMEDIA [3 0 0 3]

Computer graphics: introduction, applications; Color models; Overview of graphics systems: raster scan and random scan; Video display devices; 3D viewing devices; Graphics software; Graphics output primitives: line, circle drawing algorithms; Basic 2D and 3D transformations: translation, scaling, rotation, shearing, reflection; Window to viewport transformation; Line and polygon clipping; Projections; Spline representations; Visible surface detection; Illumination and shading models; MultDmedia: Introduction and applications; Interactive graphics systems; Images: file systems, image compression; Sound: file systems, adding sound to multimedia projects; Animation: file systems and techniques; Videos: working, file systems, codecs, compression standards; Authoring systems; Visualization in multimedia; Data and information visualization; Multimedia on the Web; Virtual reality.

References:

1. D. Hearn, M. Baker, W. Carithers, *Computer Graphics with OpenGL*, (4e), Pearson, 2013
2. D. Hearn, M. Baker, *Computer Graphics C Version*, (2e), Pearson, 2002
3. Z. Xiang, R. Plastok, *Schaum's Outlines Computer Graphics*, (2e), McGraw-Hill Education, 2006
4. J. D. Foley, A. V. Dam, S. K. Feiner, F. H. John, *Computer Graphics Principles and Practice in C*, (2e), Pearson, 2002
5. T. Vaughan, *Multimedia: Making it work*, (9e), McGraw Hill Education, 2017
6. E. Angel, *Interactive Computer Graphics- A top down approach using OpenGL*, (5e), Pearson Education, 2012

CC4153: USER INTERFACE DESIGN [3 0 0 3]

Introduction to graphics interface: characteristics of graphics interface, direct manipulation, graphical system, web user interface, popularity, characteristic and principles, usability of interactive systems, guidelines, principles, and theories, managing design processes, evaluating interface designs, software tools & visual prototyping, direct manipulation and virtual environment, menu selection, form fill in, and dialog boxes, command and natural languages, quality of service, balancing function and fashion; Windows: characteristics, components, presentation styles, types, managements, organizations, operations, web systems, device, based controls characteristics, screen, based controls, operate control, text boxes, selection control, combination control, custom control, presentation control.

References:

1. B. Shneiderman, C. Plaisant, *Designing the User Interface,* (4e), Addison Wesley, 2005.
2. B. Shneiderman, C. Plaisant, S.Jacobs, *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, (6e), 2017.
3. W.O. Galitz, *The Essential Guide to User Interface Design*, (3e), John Wiley & Sons, 2001.

CC4154: DIGITAL IMAGE PROCESSING [3 0 0 3]

Elements of digital image processing systems: vidicon and digital camera working principles, elements of visual perception, brightness, contrast, hue, saturation, Mach band effect; Color image fundamentals: RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms: DFT, DCT, KLT, SVD; Histogram equalization and specification techniques: noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, homomorphic filtering; Color image enhancement image restoration: degradation model, unconstrained restoration: lagrange multiplier and constrained restoration, inverse filtering-removal of blur caused by uniform linear motion, wiener filtering; Geometric transformations-spatial transformations: edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging; Segmentation: basic concepts, dam construction, watershed segmentation algorithm; Need for data compression: Huffman, run length encoding, shift codes, arithmetic coding, vector quantization, transform coding, JPEG standard, MPEG.

References:

1. R. C. Gonzalez, R. E. Woods, *Digital Image Processing,* (4e), Pearson, 2018.
2. K. Jain, *Fundamentals of Digital Image Processing*, (2e), Pearson, 2002.
3. W. K. Pratt, *Digital Image Processing,* (4e), Wiley-Interscience, 2007.
4. Rosenfled , A. C. Kak, *Digital Picture Processing*, Academic Press, 1986

CC4155: BIG DATA ANALYTICS [3 0 0 3]

Data definitions and analysis techniques: Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing. Descriptive Statistics: Measures of central tendency, Measures of location of dispersions, Basic analysis techniques: Relationship analysis, Correlation analysis Statistical hypothesis generation and testing, z-test, t-test, chi-square test, f-test, Analysis of variance, Maximum likelihood test. Data analysis techniques: Regression analysis, Classification techniques, Clustering, Association rules analysis. Unsupervised Learning, Recommendation Systems. Streaming Algorithms, Hadoop: Distributed Architecture, HDFS, MapReduce, Spark, Similarity Search, Link Analysis. Case studies and projects: Understanding business scenarios, Feature engineering and visualization, Sensitivity Analysis.

References:

1. R. E. Walpole, R. H. Myers, S. L. Myers, K. Ye, *Probability and statistics for engineers and scientists*, (9e), Pearson Education, 2014.
2. G. James, D. Witten D, T. Hastie, R. Tibshirani, *Statistical Learning. In: An Introduction to Statistical Learning. Springer Texts in Statistics*, vol 103, Springer, New York, 2013.
3. 3.H. Trevor, T. Robert, F. Jerome, *The elements of statistical learning: data mining, inference, and prediction*, (2e), Springer-Verlag New York, 2009.
4. J. Leskovec, A. Rajaraman, J. D. Ullman, *Mining of massive datasets*, (2e), Cambridge university press, 2014.

CC4156: DATA MINING AND DATA WAREHOUSING [3 0 0 3]

Introduction to data, information, knowledge and wisdom; Data objects and attribute types; KDD process; Introduction to data warehouse; Data preprocessing: data cleaning, integration, reduction and transformation; Data discretization and concept hierarchy generation; Comparison of OLAP with OLTP systems, ROLAP, MOLAP and DOLAP; Data cube computation methods; Multi-dimensional modeling; Data warehouse architecture and implementation : Parallel execution, materialized views; Data mining: introduction to data mining, classification of data mining systems, integration of a data mining system with a data warehouse; Classification: association rule mining (mining frequent patterns, mining various kinds of association Rules), decision tree induction, rule-based classification, back-propagation, associative classification; Clustering methods: basic statistical descriptions of data, measuring data similarity and dissimilarity, partition based clustering, hierarchical based clustering, model-based clustering; Application trends in data mining; Cluster analysis; Case study on data mining with data sets.

References:

1. J. Han, M. Kamber, *Data Mining: Concepts and Techniques*, (3e), Elsevier Publications, 2011.
2. Witten, E. Frank, M. Hall, C.Pal, *Data Mining: Practical Machine Learning Tools and Techniques*, (4e), Elsevier Publications, 2016.
3. P.N. Tan, M. Steinbach, V. Kumar, *Introduction to Data Mining,* (1e), Pearson Education, 2016.
4. S. Sumathi, S.N. Sivanandam, *Introduction to Data Mining and its Applications*, (1e), Springer, 2006

CC4157: SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction to Social Web: Nodes, Edges and Network measures, Describing Nodes and Edges, Describing Networks, Layouts; Visualizing Network features: The role of Tie Strength, Measuring Tie Strength, Tie Strength and Network Structure, Tie Strength and Network Propagation, Link Prediction, Entity Resolution; Link Prediction: Case Study Friend Recommendation, Introduction to Community Discovery, Communities in Context, Quality Functions; Algorithms: The Kernighan-Lin algorithm, Agglomerative Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering, Other Approaches; Introduction to Social Influence: Influence Related Statistics, Social Similarity and Influence, Homophile, Existential Test for Social Influence, Influence and Actions, Influence and Interaction, Influence Maximization in Viral Marketing.

References:

1. J. Goldbeck, *Analyzing the Social Web,* Morgan Kaufmann, 2013.
2. C. C. Aggarwal, *Social Network Data Analytics*, Springer, 2011.
3. J. Scott, *Social Network Analysis, (3e),* SAGE Publications, 2013.
4. Jay Goldman, *Facebook Cookbook*, O'Reilly, 2009.
5. S.Kumar, F. Morstatter, H. Liu, *Twitter Data Analytics*, Springer, 2013.

CC4158: SOFTWARE TESTING [3 0 0 3]

Basics of software testing: Introduction to software Testing, Testing and debugging, Test metrics and measurements, Verification, Validation and Testing, Types of testing, Software defect tracking; Structural testing techniques: Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing; Functional testing techniques: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique, Ad hoc Testing; Top down and Bottom up integration: Bi-directional integration, System integration, Scenario Testing, Defect Bash, Design/Architecture verification, Deployment testing, Beta testing, Scalability testing, Reliability testing, Stress testing; Acceptance testing; Regression testing, Test Planning; Software Test Automation: Scope of automation, Design & Architecture for automation, Generic requirements for test tool framework, Test tool selection, Testing in Object Oriented Systems, Case study on software testing; Advanced Topics on Testing: Prioritizing the Test-cases, Testing event driven applications, Testing Off-the-shelf component, Testing security, Testing Data-warehouse; Introduction to DevOps.

References:

1. R. Mall, *Fundamentals of Software Engineering,* (4e), Prentice Hall of India, 2014.
2. K. K. Aggarwal, Y. Singh, *Software Engineering*, (3e), New Age International Publication, 2008.
3. K. Perry, *Effective Methods for Software Testing*, (3e), Wiley, 2006.
4. B. Beizer, Software Testing Techniques, (2e), Wiley, 2008.
5. S. Desikan, G. Ramesh, *Software Testing: Principles and Practices*, Pearson Education, 2006.
6. P. C. Jorgenson, *Software Testing: A Craftsman's Approach,* (4e), CRC Press, 2014.
7. P. Mathur, *Fundamentals of Software Testing,* (2e), Pearson Education, 2014.

CC4159: CLOUD COMPUTING [3 0 0 3]

Introduction: distributed computing and enabling technologies, cloud fundamentals: cloud definition, evolution, architecture, applications, deployment models, service models and FOG computing; Virtualization: issues with virtualization, virtualization technologies and architectures, internals of virtual machine monitors/hypervisors, virtualization of data centers, and issues with multi-tenancy; Implementation: study of cloud computing systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, build private/hybrid cloud using open source tools, deployment of web services from inside and outside a cloud architecture, Map-Reduce and its extensions to cloud computing, HDFS, and GFS; Interoperability and service monitoring: issues with interoperability, vendor lock-in, interoperability approaches, SLA management, metering issues, and report generation; Resource management and load balancing: distributed management of virtual infrastructures, server consolidation, dynamic provisioning and resource management, resource optimization, resource dynamic reconfiguration, scheduling techniques for advance reservation, and load balancing, various load balancing techniques; Migration and fault tolerance: broad aspects of migration into cloud, migration of virtual machines and techniques; Fault tolerance mechanisms: grid of clouds, green cloud, mobile cloud computing.

References:

1. R. Buyya, J. Broberg, A. Goscinski, *Cl*oud *Computing Principles and Paradigms*, (1e), Wiley, 2013.
2. Sosinsky, *Cloud Computing Bible*, (1e), Wiley, 2011.
3. M. L. Miller, *Cloud Computing: Web-based Applications that change the way you work and collaborate online*, (1e), Pearson Education, 2008.
4. D. S. Linthicum, *Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide,* (1e)*, Addision* Wesley Information Technology Series, 2010.
5. T. Velte, A. T. Velte, R. Elsenpeter, *Cloud Computing: A Practical Approach*, (1e), McGraw Hill, 2017.

CC4160: Information Theory and Coding [3 0 0 3]

Information Theory: introduction, entropy, information rate, channel capacity, Kraft McMillan inequality, Shannon-Fano coding, Huffman coding, extended Huffman coding - joint and conditional entropies, discrete memoryless channels: BSC, BEC; Error Control Coding: block codes, convolutional codes, code tree, trellis, state diagram, single parity codes, hamming codes, repetition codes, linear block codes, cyclic codes, encoder and decoder – CRC, sequential search, Viterbi algorithm; Text Source Coding; Audio Source Coding; Image and Video Source Coding: image and video formats (GIF, TIFF, etc.), image compression, video compression, H.261, MPEG standard.

References:

1. R. Bose, *Information Theory, Coding and Cryptography*, (3e), TMH, 2017.
2. F. Halsall, *Multimedia Communications: Applications, Networks, Protocols and Standards*, (2e), Pearson, 2001.
3. K. Sayood, *Introduction to Data Compression*, (4e), Morgan Kaufmann, 2012.
4. S. Gravano, *Introduction to Error Control Codes*, (2e), Oxford University Press, 2007.
5. Bhattacharya, *Digital Communication*, (1e), McGraw Hill Education, 2017.

CC4161: NETWORK SECURITY [3 0 0 3]

Basics of network security: attacks, IP spoofing, packet sniffing, services and mechanisms; Network security applications: Kerberos, key management, man in the middle attack, replay attack, digital certificate, PKI, IPSec, IKE, SSL, TLS, PGP, MIME, SSH, entity authentication; Network defense: firewalls, VPN, IDS, need of firewalls, firewall characteristics, access policy, type of firewall, firewall location and configuration, types of IDS, working of IDS and policies; Malicious software: virus, worm, Trojan horse, identification and remedies; Internet security; Secure electronic payment system and protocols.

References:

1. W. Stallings, *Cryptography and Network Security-Principles and Practice*, (7e), Pearson Education, 2017.
2. W. Stallings, *Network Security Essentials: Applications and Standards*, (6e), Pearson Education, 2018.
3. B. A. Forouzan, D. Mukhopadhyay, *Cryptography and Network Security*, (3e), McGraw Hill, 2015.
4. Y. Qian, D. Tipper, P. Krishnamurthy, J. Joshi, *Information Assurance Dependability & Security in Networked Systems*, (1e), Morgan Kaufmann, 2010.
5. Sadeghi, M. Schneider, *Electronic Payments Systems*, (1e), Springer, 2003.
6. R. D. Pietro, L. V. Mancini, *Intrusion Detection Systems*, (1e), Springer, 2010.

CC4162: SPATIAL DATA ANALYTICS [3 0 0 3]

Introduction to geospatial data: concepts of spatial data, spatial data storage, representation and different formats, modes of geographic information- aerial photo and image interpretation; Geospatial data processing: data extraction, vector and raster data handling and transformation; Spatial referencing using coordinate system and geographic identifiers, metadata; Spatial Database, spatial query SQL, NoSQL using Oracle spatial extension; Geo-processing of vector and raster data; Spatial data analysis using commercial & open source software-QGIS & SAGA, eo-statistics, and spatial uncertainty, quality of spatial data; GIS analysis functions: retrieval, classification, measurement, neighborhood, topographic, interpolation, overlay, buffering, spatial join and query, connectivity, network functions, spatial pattern analysis, spatial autocorrelation, trend surface analysis; Spatial data mining: classification, patterns, and rules. Introduction to remote sensing: sensors and their characteristics on board remote sensing satellites; Spectral reflectance of soil, water, vegetation and rock types; Data interoperability, extensibility, data visualization and case studies using open source software and python libraries; Advanced topics of 3-DGS & 4-DGS.

References:

1. M. N. DeMers, *Fundamentals of Geographic Information Systems,* (4e), John Wiley & Sons, 2008.
2. M. M. Fischer, J. Wang, *Spatial Data Analysis: Models, Methods and Techniques*, Springer Science & Business Media, 2011.
3. D. L. Wang, D. L. Shuliang, *Spatial Data Mining*, Berlin, Heidelberg: Springer Berlin Heidelberg, 2015.
4. C. Lloyd, *Spatial Data Analysis: An Introduction for GIS Users,* (1e), Oxford University Press, 2010.
5. R. Haining, *Spatial Data Analysis: Theory and Practice,* Cambridge University Press, 2013.
6. J. R. Jensen, *Introductory Digital Image Processing: A Remote Sensing Perspective*, Prentice Hall Press, 2015.
7. H. Wackernagel, *Multivariate Geostatistics: An Introduction with Applications*, Springer Science & Business Media, 2010.
8. J. Lawhead, *Learning Geospatial Analysis with Python*. Packt Publishing Ltd, 2013.

OPEN ELECTIVES

CC2080: INTRODUCTION TO DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

Introduction: algorithm specification; Performance analysis: time and space complexity, asymptotic notation; C revision: pointer declaration and definition, memory allocation functions, array of pointers, structures in C, arrays of structures, structures and functions; Recursion in C; Linked list: implementation, various types and operations; Stack: implementations using array and linked list, operations and its applications; Queue: implementations using array and linked list, operations and its applications; Tree: terminologies, different types, implementations of binary tree using array and linked structure, binary search tree, different operations (recursive, non-recursive), search trees, tree applications; Graph: implementation and operations; Searching techniques and hashing; Sorting.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, Fundamentals of Data Structures in C, (2e), Orient Black Swan, 2008.
2. A.M. Tenenbaum, Y. Langsam, M. J. Augenstein, Data Structures using C, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, Data Structures and Algorithms, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to algorithms, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, Data Structures with C (Schaum's Outline Series), (3e), McGraw Hill, 2011.
6. M. A. Weiss, Data structures and Algorithm Analysis in C, (1e), Pearson Education, 2002.

CC3080: INTRODUCTION TO OBJECT ORIENTED PROGRAMMING [3 0 0 3]

Introduction: need of object oriented programming, difference between procedural and object oriented language; Characteristics of object oriented programming; Programming basics: basic program construction, directives, comments, tokens, keywords, identifiers and constants; Data types: basic, user defined, derived; Operators: insertion and exertion operators, scope resolution operator, member access operator; Manipulators; Type casting; Functions: function declaration, function definition, function calling; Recursive functions; Passing arguments; Returning values; Objects and classes: defining classes, object creation, access specifiers; Constructors and its types; Inline functions; Friend functions; Inheritance; Abstract class; Virtual base class; This pointer; Polymorphism: compile time and runtime.

References:

1. H. Schilt, C++: The Complete Reference, (4e), McGraw Hill Education, 2017
2. E. Balagurusamy, Object Oriented Programming with C++, (7e), McGraw-Hill Education, 2017
3. R. Lafore, Object Oriented Programming in C++, (4e), Pearson, 2008

CC3081: INTRODUCTION TO WEB TECHNOLOGY [3 0 0 3]

Web designing: introduction to WYSIWYG design tools, introduction to HTML, introduction to CSS, introduction to word press, website creation and maintenance, web hosting and publishing concepts; Client side programming: the JavaScript language, history and versions, syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built-in objects, JavaScript debuggers; Representing web data: XML documents and vocabularies versions and declaration- namespaces, displaying xml documents in browsers; Server side programming: overview-servlets & life cycle, java server pages, generating dynamic content, parameter data, sessions, cookies; Electronic commerce: e - business model, e - marketing, online payments and security.

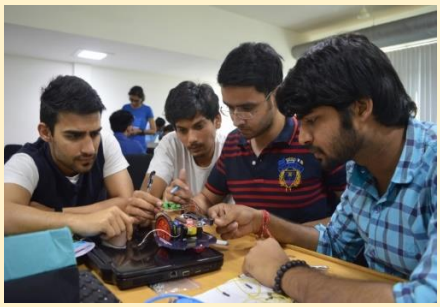
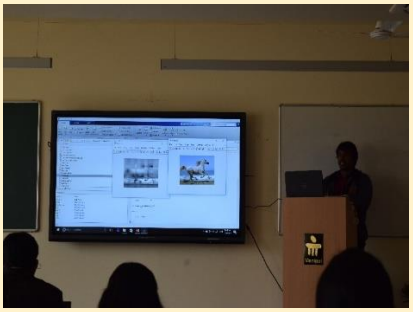
References:

1. DT. E. Services, HTML 5 Black Book, (2e), Dreamtech Press, 2016.
2. J. Sklar, Web Design Principles, (5e), Cengage, 2015.
3. P. J. Deitel, H. M. Deitel, Internet and World Wide Web How to program, (5e), Pearson, 2011.
4. R. Moseley, M. T. Savaliya, Developing Web Applications, (1e), John Wiley & Sons, 2007.
5. J. C. Jackson, *Web Technologies: A Computer Science Perspective*, Pearson Education, 2007.
6. S. Potts, *JAVA 2 Unleashed*, (6e), Sams Publishing, 2002.

Department of Computer Science & Engineering

CSE department offers courses related to cutting-edge technologies and research domain through seven different department electives tracks as Cloud Computing, Cyber Security, Data Science, Computer Vision & Image Processing, Web Technologies, Computational Intelligence, Sensor Networks & IoT. In 3rd year students can opt for two department electives and subsequently five department electives in 7th semester. Department is having quality & enriched learning resources with 795 book and 4788 volumes. To facilitate research capabilities more than 7217 e-journal subscription are available with 10 National journal and 3 national magazines. School of Computing and IT has the most up-to-date computing labs to support the research and teaching activities. There are three computer center and thirteen labs in the school with Windows and Linux platform.

An extensive software library is maintained in all labs. Some of the specialized labs. are: Computing Research Lab, Database (Oracle) Lab, Big Data & Machine Learning Lab, ERP (SAP) Lab, Cyber Security (EC-Council) Lab, and Cloud Computing (VMware) Lab. Apart from curriculum, these labs are used various certification programs like SAP-BASIS, SAP-ABAP, Certified Ethical Hacker, EC-Council Certified Security Specialist etc. PARAM Shavak - Supercomputing facilities powered with two multicore CPUs each with minimum 12 cores, 3 Tera-Flops peak computing power with 8 TB of storage, pre-loaded with parallel programming development tools and libraries. Florida International University, Greater Miami, Florida US, University of Applied Science, Western Switzerland, Summer University Switzerland Courses at Singapore, Electronic & Computer Engineering Division, Ngee Ann Polytechnic, Singapore., CESI France & Addendum 1 CESI France, St. Cloud State University Minnesota, USA, Iowa State University, USA. ARM, CISCO, Dell, EC Council, Microsoft, Microchip/ATMEL, Oracle Academy, CDAC, SAP Academy, VMware IT Academy.


B.Tech in Computer Science & Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	EO2001	Economics	3	0	0	3	BB0025	Value, Ethics and Governance	2	0	0	2
	MA2101	Engineering Mathematics – III	2	1	0	3	MA2201	Engineering Mathematics – IV	2	1	0	3
	CS2101	Data Communications	3	1	0	4	CS2201	Operating Systems	3	1	0	4
	CS2102	Computer System Architecture	3	1	0	4	CS2202	Relational Database Management Systems	3	1	0	4
	CS2103	Data Structures & Algorithms	3	1	0	4	CS2203	Computer Organization	3	1	0	4
	CS2104	Object Oriented Programming	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	CS2130	Data Structures & Algorithms Lab	0	0	2	1	CS2230	Operating Systems Lab	0	0	2	1
	CS2131	Object Oriented Programming Lab	0	0	2	1	CS2231	Relational Database Management Systems Lab	0	0	2	1
							CS2232	Web Technology Lab	0	0	2	1
			17	5	4	24			16	4	6	23
	Total Contact Hours (L + T + P)		25				Total Contact Hours (L + T + P) + OE		26			
	FIFTH SEMESTER						SIXTH SEMESTER					
III	CS3101	Artificial Intelligence & Soft Computing	3	1	0	4	BB0026	Organization and Management	3	0	0	3
	CS3102	Design & Analysis of Algorithms	3	1	0	4	CS3201	Software Engineering	3	1	0	4
	CS3103	Automata Theory & Compiler Design	3	1	0	4	CS3202	Information Systems Security	3	1	0	4
	CS3104	Computer Networks	3	1	0	4	CS3203	Data Science and Machine Learning	3	0	0	3
	CS31XX	Program Elective – I	3	0	0	3	CS32XX	Program Elective – II	3	0	0	3
	XXXXXX	Open Elective – II	3	0	0	3	XXXXXX	Open Elective – III	3	0	0	3
	CS3130	Design & Analysis of Algorithms Lab	0	0	2	1	CS3230	Software Engineering Lab	0	0	2	1
	CS3131	Artificial Intelligence & Soft Computing Lab	0	0	2	1	CS3231	Information Systems Security Lab	0	0	2	1
	CS3132	Computer Networks lab	0	0	2	1	CS3270	Minor Project	0	0	6	3
			18	4	6	25			18	2	10	25
	Total Contact Hours (L + T + P) + OE		28				Total Contact Hours (L + T + P) + OE		30			
	SEVENTH SEMESTER						EIGHTH SEMESTER					
IV	CS41XX	Program Elective – III	3	0	0	3	CS4270	Major Project				12
	CS41XX	Program Elective – IV	3	0	0	3						
	CS41XX	Program Elective – V	3	0	0	3						
	CS41XX	Program Elective – VI	3	0	0	3						
	CS41XX	Program Elective – VII	3	0	0	3						
	CS41XX	Industrial Training	0	0	2	1						
			15	0	2	16						12
	Total Contact Hours (L + T + P)		17				Total credits=169(including first year)					

THIRD SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR,AR,MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies,Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e) S. Chand Publication.
2. Peterson H C et.al., *Managerial Economics*, (9e), Pearson, 2012
3. P L Mehta, *Managerial Economics*, Sultan Chand & Sons, New Delhi, 2012.
4. G J Tuesen & H G Tuesen, *Engineering Economics*, PHI, New Delhi, 2008.
5. J. L. Riggs, D. D. Bedworth, S. U. Randhawa, *Engineering Economics*, Tata McGraw Hill, 2018.

MA2101: ENGINEERING MATHEMATICS III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices and Boolean Algebra. Propositional and Predicate Calculus: Wellformed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. Elementary configuration: Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. Ordering of permutations: Lexicographical and Fikes. Graph theory: Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path, Algorithm. Group theory: Semi groups, Monoids, Groups subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. C. L. Liu, *Elements of Discrete Mathematics, (2e)*, Mc Graw Hill, New Delhi, 2007.
2. J. P. Trembaly and R. Manohar, *Discrete Mathematics Structures with application to computer science*, Tata Mc Graw Hill, 2012.
3. E. S. Page and L. B. Wilson, *An Introduction to Computational Combinatorics*, Cambridge Univ. Press, 1979.
4. N. Deo, *Graph theory with Applications to computer science*, PHI, 2012.

CS2101: DATA COMMUNICATIONS [3 1 0 4]

Introduction: Data communications, Networks, Network types, Standards. Protocol Layering: Protocol, Need for protocol architecture, OSI Model, TCP/IP protocol architecture. Data Transmission: Concepts and terminology, Analog and digital data transmission, Transmission impairments, Channel capacity, Transmission Media: Guided transmission media, Wireless transmission, Wireless propagation, Line-of-Sight transmission. Signal Encoding Techniques: Analog and digital Signals, Digital-to-digital conversion: Line coding schemes, Block coding, scrambling, Analog-To-Digital Conversion: Pulse code modulation, Delta modulation. Digital Data Communication Techniques: asynchronous and synchronous transmission, Types of errors, Error detection, Error correction, Line configurations. Data Link Control Protocols: Flow control, Error control, High-level data link control. Multiplexing: Frequency-division multiplexing, Time-division multiplexing, Code-division multiple access. Space division multiplexing. Multiple Access: Random access, Aloha, Carrier sense multiple access, Carrier sense multiple access with collision detection, Carrier sense multiple access with collision avoidance, Code-division multiple access.

References:

1. B. Forouzan, *Data Communication & Networking,* (5e), McGraw Hill Education, 2013.
2. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education, 2018.

CS2102: COMPUTER SYSTEM ARCHITECTURE [3 1 0 4]

Digital Logic Circuits: Logic Gates, Boolean algebra, Map Simplification, Combinational Circuits, Flip-Flops, Sequential Circuits. Digital Components: Integrated Circuits, Decoders, Multiplexers, Registers, Shift Registers, Binary Counters, Memory Unit. Basic Structure of Computers: Computer Types, Functional Units, Basic Operational Concepts, Software, Performance. Machine Instructions and Programs: Numbers, Arithmetic Operations and Characters, Memory Locations and Addresses, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Additional Instructions, Encoding of Machine Instructions. Arithmetic: Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating Point Numbers and Operations.

References:

1. M. Morris Mano, *Computer System Architecture*, (3e), Pearson, 2017.
2. C. Hamacher, Z. Vranesic, S. Zaky, *Computer Organization and Embedded Systems*, (6e), McGraw Hill, 2012.
3. J. P. Hayes, *Computer Architecture and Organization*, (3e), McGraw Hill TMH, 2012.

CS2103: DATA STRUCTURES & ALGORITHMS [3 1 0 4]

Introduction: Data structures classification, time and space complexity, pointers and pointer applications, Accessing variables through pointers, structures, functions. Array: introduction, Linear array, representation of an array in memory, multi-dimensional arrays, pointer arrays, matrix operations. Linked Lists: Introduction, single linked list, representation of a linked list in memory, Different Operations on a Single linked list, Reversing a single linked list, Advantages and disadvantages of single linked list, circular linked list, doubly linked list and Header linked list. Applications: polynomial operations and Josephus problem. Stacks: Basic Stack Operations, implementation of a Stack using Static Array, Dynamic Array and linked list, Multiple stack implementation using single array, Stack Applications, Reversing list, Factorial Calculation, Infix to postfix conversion, evaluation of Arithmetic Expressions and Towers of Hanoi. Queues: Basic Queue Operations, Representation of a Queue using array and linked list, Implementation of Queue Operations using Stack, Applications of Queues, Round Robin Algorithm, Circular Queues, DeQueues, Priority Queues. Trees: Definition of tree, Properties of tree, Binary Tree, Representation of Binary trees using arrays and linked lists, Operations on a Binary Tree, Threaded binary tree, Binary Tree Traversals (recursive and using stack), Binary search tree, AVL tree, m-way tree, B-tree, B+ tree Graphs: Basic concepts, Different representations of Graphs, Graph Traversals (BFS & DFS), Minimum Spanning Tree (Prims & Kruskal). Searching Techniques: Sequential and binary search. Hashing: Hash function, Address calculation techniques, and Common hashing functions, Collision resolution, Linear and Quadratic probing, Double hashing. Sorting Techniques: Basic concepts, Sorting by: bubble sort, Insertion sort, selection sort, quick sort, heap sort, merge sort, radix sort.

References:

1. A. S. Tannenbaum, J. Augenstein, *Data Structures using C*, Pearson India, 2018.
2. E. Horowitz, S. Sahni, *Fundamentals of Data Structures in C*, (2e), Universities Press, 2008.
3. A. Forouzan, R. F. Gilberg, *A Structured Programming Approach Using C*, (3e), Cengage Learning, 2006.

CS2104: OBJECT ORIENTED PROGRAMMING [3 1 0 4]

The History and Evolution of object-oriented technology: benefits of object-oriented programming (OOP), application of object-oriented programming (OOP), introduction to object-oriented programming language like Java, C# and C++. Programming Fundamentals: Control flow statements, operators, datatypes, Type conversion, Wrapper Classes, Arrays. Introduction to classes: Class fundamentals, declaring objects, Assigning Object reference variables, Introduction to methods, Constructors, Method Overloading, objects as parameters, argument passing, returning objects, recursion, access control, final, nested and inner classes. I/O Basics: Reading Console Input, Writing Console Output, Files handling. Inheritance: base and derived class, multilevel hierarchy, access modifier in inheritance, method overriding, abstract classes. Exception Handling: Exception types, creating exception, Try Catch construct, Throw and throws keyword. Multithreaded programming: Creating and running threads, synchronise methods, inter thread communication, suspending, resuming and stopping thread.

References:

1. M. Weisfeld, *The object-oriented thought process*, (4e), Pearson, 2013.
2. H. Schildt, *The Complete Reference Java*, (10e), Oracle Press, 2018.
3. C. Horstmann, *Core Java Volume I—Fundamentals*, (10e), Prentice Hall, 2006.
4. H. Schildt, *The Complete Reference C++,* (4e), Mcgraw Hill, 2003.

CS2130: DATA STRUCTURES & ALGORITHMS LAB [0 0 2 1]

Implementation of array operations: insertion, deletion, linear search and binary search, matrix operation. Implementation of singly, doubly and circular linked lists: inserting, deleting, and inverting a linked list, Polynomial addition, subtraction and sparse matrix implementation by linked list, Josephus problem. Stacks and Queues: adding, deleting elements. Circular Queue: Adding & deleting elements, conversion of infix to postfix and Evaluation of postfix expressions using stacks & queues, Implementation of stacks & queues using linked lists. Recursive and Non-recursive traversal of Trees: Threaded binary tree traversal, BST and AVL tree implementation. Implementation of sorting and searching algorithms: bubble sort, Insertion sort, selection sort, quick sort, heap sort, merge sort, radix sort, Hash table implementation.

References:

1. A. S. Tannenbaum, J. Augenstein, Data Structures using C, Pearson India, 2018.
2. E. Horowitz, S. Sahni, Fundamentals of Data Structures in C, (2e), Universities Press, 2008.
3. A. Forouzan, R. F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning, 2006.

CS2131: OBJECT ORIENTED PROGRAMMING LAB [0 0 2 1]

Introduction to object-oriented programming language: Basic programming construct, flow control, loops, data type and arrays. Introduction to classes and object: creating class and object, using object to access class members, declaring method in class, recursion, argument passing and returning, declaring constructor, constructor overloading and method overloading. Input-output: Basic technique for input and output, type casting, file handling. Inheritance: creating base class and derive class, use of different access modifier, overriding base class methods, creating abstract classes/interfaces. Exception handling: try catch construct, creating own exception, raising exception. Multi thread programming: creating and running thread, stopping thread, use of wait, inter thread communication.

References:

1. H. Schildt, *The Complete Reference Java*, (10e), Oracle Press, 2018.
2. C. Horstmann, *Core Java Volume I—Fundamentals*, (10e), Prentice Hall, 2006.
3. H. Schildt, *The Complete Reference C++*, (4e), Mcgraw Hill, 2003.

FOURTH SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications.

MA2201: ENGINEERING MATHEMATICS IV [2 1 0 3]

Basic Set theory, Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One dimensional and two dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. Functions of random variables: One dimensional and Two dimensional, F & T distributions , Moment generating functions, Sampling

theory, Central limit theorem, Point estimation, MLE, Interval estimation, Test of Hypothesis : significance level, certain best tests; Chi square test.

References:

1. P. L. Meyer, *Introduction to probability and Statistical Applications*, (2e), Oxford and IBH publishing, 1980.
2. Miller, Freund and Johnson, *Probability and Statistics for Engineers*, (8e), PHI, 2011.
3. Hogg and Craig, *Introduction to mathematical statistics*, (6e), Pearson education, 2012.
4. S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Elseveir, 2010.

CS2201: OPERATING SYSTEMS [3 1 0 4]

Introduction: Definition of operating systems, Single and multi-processor systems, Operating system Services, System commands and system calls, Interrupt, System boot. OS Structure: Simple, Layered, Microkernel, Hybrid, Modules, Types of OS, Multi-user, Multitasking, Embedded, Real-time, Network, Distributed. Virtualization: Introduction, Hypervisor, Data center, Virtual data center, VMware virtualization products. Process and Thread: Process concept, Operations on processes, Inter-process communication, UNIX pipes, Multithreading, Multithreaded models, PThread API. Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms. Synchronization: Critical section problem, Peterson solution, Synchronization hardware, Semaphores, Classical problems of synchronization, Deadlock, Methods for handling deadlock. Memory Management: Swapping, Contiguous memory allocation, Paging, Structure of Page Table, Segmentation, Demand Paging, Page Replacement Policies, Allocation of Frames, Thrashing. File System Interface and Implementation: File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File System Structure, File System Implementation, Allocation Methods, Free Space Management. Disk Management: Disk Scheduling Algorithms, Disk Management, Swap Space Management.

References:

1. A. Silberschatz, P. B. Galvin, G. Gagne, *Operating System Concepts*, (9e), Wiley, 2014.
2. A.S. Tanenbaum, H. Bos, *Modern Operating Systems*, (4e), Pearson, 2015.
3. W. Stallings, *Operating Systems: Internals and Design Principles*, (9e), Pearson, 2018.

CS2202: RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: Database systems, RDBMS Definition, data models, 3-schema architecture, challenges in building RDBMS, different components of a RDBMS. Relational Data Model: Concept of relations and its characteristics, schema-instance, integrity constraints, E/R Model, Extended E/R Model, converting the database specification in E/R and Extended E/R notation to the relational schema. Relational Query Language: Relational Algebra operators-selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus, introduction to SQL, data definition in SQL, table and different types of constraints definitions, data manipulation in SQL, nested queries, notion of aggregation. Relational Database Design: functional dependencies and Normal forms, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF. Transaction Processing: concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods. Data Storage and Indexing: file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B-tree and B+ trees.

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.
4. I. Bayross, *SQL, PL/SQL The Programming Language of Oracle*, (4e), BPB Publications, 2010.
5. C. J. Date, *An Introduction to Database Systems*, (8e), Prentice Hall of India, 2006.

CS2203: COMPUTER ORGANIZATION [3 1 0 4]

Processor Datapath and Control: Logic Design Conventions, Building a Datapath, Implementation Schemes, Exceptions, Microprogramming. Pipelining: Overview, Pipelined Datapath, Pipelined Control, Data Hazards and Forwarding, Data Hazards and Stalls, Branch Hazards. Memory Hierarchy: Basics of Caches, Measuring and Improving Cache Performance, Virtual Memory, Address Translation. Storage and Other Peripherals: Disk Storage and Dependability, Networks, Connecting I/O Devices to Processor and Memory, Interfacing I/O Devices to the Memory,

Processor, and Operating System, I/O Performance Measures, Redundant Array of Inexpensive Disks. Multicores, Multiprocessors and Clusters: Shared Memory Multiprocessors, Clusters and other Message-Passing Multiprocessors, Hardware Multithreading, SISD, MIMD, SIMD, SPMD and Vector Processors.

References:

1. D. A. Patterson, J. L. Hennessy, *Computer Organization and Design: The Hardware and Software Interface*, (5e), Elsevier, 2017.
2. J. L. Hennessy, D. A. Patterson, *Computer Architecture: A Quantitative Approach*, (6e), Morgan Kaufmann Publishers, 2019.
3. W. Stallings, *Computer Organization and Architecture –Designing for Performance*, (9e), Pearson, 2013.

CS2230: OPERATING SYSTEMS LAB [0 0 2 1]

Basic Linux commands: Illustration of shell functions, wild cards, redirection, pipes, sequencing, grouping, background processing, command substitution, sub shells, Shell programming. System Calls: File and process, I/O Redirection, IPC using Pipe and Signals. PThread API: Multithreaded programs, Synchronization programs using PThreads and Semaphores, CPU Scheduling, Deadlock, Memory Management. Creating a Virtual Machine: Virtual Machine Files and Snapshots, Virtual Machine Cloning and Exporting.

References:

1. W. R. Stevens , S. A. Rago*, Advanced Programming in the UNIX Environment,* (3e), Addison-Wesley, 2013.
2. S. Das, *Unix Concepts and Applications*, (4e), McGraw Hill, 2006.
3. K. A. Robbins, S. Robbins, *Unix Systems Programming: Communication, Concurrency, and Threads*, (2e), Prentice Hall, 2004.

CS2231: RELATIONAL DATABASE MANAGEMENT SYSTEMS LAB [0 0 2 1]

Introduction to SQL and its different command categories i.e. DDL, DML, DQL and DCL, Data Integrity Constraints and Built-in Functions, Design and implementing the data requirements of a simple DB application, Experiments on views, indexing, triggers, stored procedures, transaction.

References:

1. I. Bayross, *Teach yourself SQL & PL/SQL using Oracle 8i & 9i with SQLJ*, BPB Publications, 2010.
2. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
3. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.

CS2232: WEB TECHNOLOGY LAB [0 0 2 1]

Introduction to WWW: Web Design, Web site design principles, planning the site and navigation. HTML: The development process, html tags, forms, web site structure. XHTML: XML, move to XHTML, meta tags, character entities, frames and frame sets, inside browser. Style Sheets: CSS1, CSS2, CSS3. JavaScript: How to develop javascript, variables, functions, conditions, loops and repetition. Advance Javascript: Javascript and objects, javascript own objects, the DOM and web browser environments, forms and validations. DHTML: Combining HTML, CSS and Javascript, events and buttons, controlling your browser. Ajax: Introduction, advantages, purpose of it, Ajax based web application, alternatives of Ajax. XML: Introduction to XML, DTD and Schemas, Well formed, using XML with application. XSL: Introduction to XSL, XML transformed simple example, XSL elements, transforming with XSLT. PHP: Starting to script on server side, arrays, function and forms, advance PHP. Databases: Connection to server, creating database, performing data and schema related operations, PHP myadmin and database bugs. Advanced topics: E-Commerce models and architecture. m-Commerce: WAP and Mobile agents, search engines and search engine optimization, Introduction to web services and technology. Introduction, pros and cons of the above technology with advance technology: JQuery, WebRTC, Web socks, Angularjs, NodeJS, JSON, Bootstrap. All above will be facilitated using Web/Mobile application projects assigned to the students.

References:

1. R. Connolly, R. Hoar, *Fundamentals of Web Development,* Pearson Education India, 2015.
2. R. Nixon, *Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5*, (5e), O'Reilly Publications, 2018.
3. L. Welling, L. Thomson, *PHP and MySQL Web Development*, (5e), Pearson Education, 2017.
4. N. C. Zakas, *Professional JavaScript for Web Developers*, (3e), Wrox/Wiley India, 2019.
5. D. S. Mcfarland, *JavaScript & jQuery: The Missing Manual*, (3e), O'Reilly/Shroff Publishers & Distributors Pvt Ltd, 2014.
6. Z. R. A. Boehm, *Murach's HTML5 and CSS3*, (4e), Murach's/Shroff Publishers & Distributors Pvt Ltd, 2018.

FIFTH SEMESTER

CS3101: ARTIFICIAL INTELLIGENCE AND SOFT COMPUTING [3 1 0 4]

Fundamental Concepts: Agents, environments, general model, Problem solving techniques. Search Techniques: Uninformed search, heuristic search, adversarial search and game trees, Solution of constraint satisfaction problems using search. Knowledge Representation: Propositional and predicate calculus, semantics for predicate calculus, inference rules, unification, Resolution, semantic networks, conceptual graphs/Dependency, structured representation. Learning: Inductive learning, decision tree learning. Natural language processing: introduction, parsing using context free grammars, Chomsky hierarchy, case grammar. Soft computing: Fuzzy set theory, Fuzzy sets, set-theoretic operations, membership functions, Union, intersection and complement, fuzzy rules, reasoning and interference. Neural networks: Perceptron, Back Propagation. Evolutionary techniques: genetic algorithms, Swarm Algorithm, ant colony optimization.

References:

1. S. Russell, P. Norvig, *Artificial Intelligence: A Modern Approach,*(3e) PHI, 2011.
2. E. Rich, K. Knight, S. B. Nair, *Artificial Intelligence,* (3e), Tata McGraw Hill, 2009.
3. G. F. Luger, *Artificial Intelligence-Structures and Strategies for Complex Problem Solving*, (6e), Addison-Wesley Pearson Education, 2012.

CS3102: DESIGN & ANALYSIS OF ALGORITHMS [3 1 0 4]

Introduction: Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Nonrecursive and Recursive Algorithms, Brute force Techniques, Divide and Conquer. Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting. Transform and Conquer: Presorting, BST, Heapsort. Space and Time tradeoffs: Input Enhancement in String Matching. Dynamic Programming: Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees, Coping with limitations of algorithmic power. Backtracking: nQueens problem, Hamiltonian Circuit Problem, SubsetSum Problem. BranchandBound: Assignment Problem, Knapsack Problem, TSP. Complexity Clasess: P, NP,and NP-complete Problems.

References:

1. E. Horowitz, S. Sahni, S. Rajasekaran, *Fundamental of Computer Algorithms*, (2e), Universities Press, 2007.
2. T. H. Cormen, C. E. Leiserson, R.L. Rivest and C. Stein, *Introduction to Algorithms*, (3e), MIT press, 2009.

CS3103: AUTOMATA THEORY & COMPILER DESIGN [3 1 0 4]

Introduction: Automata Theory, Mathematical Preliminaries and Notation, Review of set theory, function, relation. Finite Automata: Deterministic and Non Deterministic Finite Automata (FA), Regular languages, Mealy and Moore machine; Regular Sets and Regular Grammars: Chomsky Hierarchy, Regular Expressions, Regular Grammar and FA, Pumping Lemma for Regular Languages**;** Context Free Languages (CFL) and Grammars: Ambiguity, Methods for Transforming Grammars**;** Push Down Automata: Nondeterministic Pushdown Automata (NPDA), Design of NPDA, PDA and CFLs**;** Introduction to Turing machine; Introduction to Compiler Design: Structure of a Compiler, Lexical Analysis, Recognition of Tokens**;** Introduction to LR Parsing: Simple LR, More Powerful LR Parsers**,** Parser Generators; Syntax Directed Translations; Type Checking: Rules for Type Checking; Storage Organization.

References:

1. P. Linz, *An Introduction to Formal Languages and Automata*, (6e), Jones and Bartlett Student Edition, 2016.
2. A. V. Aho, J. Ullman, M. S. Lam, R. Sethi, *Compilers: Principles, Techniques and Tools*, (2e), Pearson Education, 2015.
3. M. Sipser, *Introduction to the Theory of Computation*, (3e), Cengage Learning, 2014.
4. J. C. Martin, *Introduction to Languages and the Theory of Computation,* (4e), McGraw Hill, 2010.

CS3104: COMPUTER NETWORKS [3 1 0 4]

Network Layer: Network layer design issues, routing algorithms, congestion control algorithms, Quality of service, MPLS, Classfull addressing, Sub-netting, Classless addressing. Protocols: ARP & DHCP, Introduction, Packet Format, message types, IPV4 header format, fragmentation, options, checksum. ICMP: Message format, message types.

Dynamic routing protocols: RIP, OSPF & BGP. Multicasting Protocol: IGMP, Introduction to IPV6. Transport Layer: Transport services, state diagram, Elements of Transport Protocols, addressing, Connection establishment, connection release, Error control and Flow Control, Multiplexing. Congestion Control: Bandwidth allocation, regulating the sending rate, UDP, TCP. Application Layer: DNS, Name space, domain resource records. Electronic Mail: SMTP, POP, IMAP, MIME, HTTP, HTTPS, SNMP. Network Security: Security Goals, Attacks, Attack prevention techniques, Firewall, IDS, DMZ, IPsec.

References:

1. B. A. Forouzan, *TCP/IP Protocol Suite*, (4e), TMH, 2010.
2. A. S. Tanenbaum, *Computer Networks*, (5e), Pearson, 2010.

CS3130: DESIGN & ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Sorting & Searching Algorithm: insertion sort, selection sort, binary search. Basic data structures: stacks and queues, graphs and trees, binary trees. Algorithmic paradigms: Recursion, divide-and-conquer, Merge sort, Quick sort. Greedy: Knapsack, Huffman encoding, dynamic programming, lower bounds and optimal algorithms. Heaps: Heaps, priority queues, min-max heaps, heap sort. Dynamic search structures: Binary search trees, height balancing, B-trees. Algorithms on arrays: Linear-time median finding, sorting in linear time (counting sort, radix sort, bucket sort), String matching (Rabin-Karp and Knuth-Morris-Pratt algorithms). Graph algorithms Traversal: (BFS, DFS, topological sort), Minimum spanning trees (Prim and Kruskal algorithms), shortest paths (Dijkstra's and Floyd-Warshal algorithms). Mini-Projects & Case Studies.

References:

1. E. Horowitz, S. Sahni, S. Rajasekaran, *Fundamental of Computer Algorithms*, (2e), Universities Press, 2007.
2. T. H. Cormen, C. E. Leiserson, R.L. Rivest , C. Stein, *Introduction to Algorithms*, (3e), MIT press, 2009.

CS3131: ARTIFICIAL INTELLIGENCE AND SOFT COMPUTING LAB [0 0 2 1]

Introduction to Python: basic variable declaration, loops, inbuilt functions. Basic Programming using Python for AI techniques: global and local heuristics, Crypt arithmetic, Python syntax, Constraint satisfaction Problem, Preposition and inference. Travelling Salesman Problem using Branch & Bound /Nearest Neighbor. Character recognition using Neural Networks. Optimization using Genetic Algorithms. Mini-Projects & Case Studies.

References:

1. A. K. Mackworth, D. L. Poole, *Artificial Intelligence: Foundations of Computational Agents*, (2e), Cambridge University Press, 2017.
2. P. Joshi, *Artificial Intelligence with Python,* Packt Publishers, 2018.
3. I. Bratko, *PROLOG: Programming for Artificial Intelligence,* (3e), Pearson Publication, 2011.

CS3132: COMPUTER NETWORKS LAB [0 0 2 1]

Cisco Packet Tracer: Introduction to packet tracer and networking device components, Router mode, Switch/Router basic commands; designing of star topology using HUB and Switch, IP configuration of end devices, Configuring DHCP server, Static routing, RIP, OSPF, VLAN and NAT. Network programming: Transmission control protocol and User datagram protocol. Network Utilities: PING, NETSTAT, IPCONFIG, IFCONFIG, ARP, TRACE-ROUTE

References:

1. B. A. Forouzan, *TCP/IP Protocol Suite, (5e)*, Tata McGraw Hill, 2013.
2. A. S.Tanenbaum, *Computer Networks, (5e),* Pearson Education, 2010.

SIXTH SEMESTER

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower**.** Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's

Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, *Essentials of Management*,(1e) Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

CS3201: SOFTWARE ENGINEERING [3 1 0 4]

Introduction: The Evolving Role of Software, The changing nature of software, Legacy software, Software Myths. Software Engineering: A Layered Technology, a Process Framework, the Capability Maturity Model Integration (CMMI), Specialized Process Models, and the Unified Process. Agile development: Agile Process Models Software Engineering Practice, Communication Practice, Planning Practices, Modeling Practices, Construction Practice, Deployment Computer–Based Systems, The System Engineering Hierarchy, Business Process Engineering: An Overview. Product Engineering: An Overview, Data Modeling Concepts, Object Oriented Analysis, Flow-Oriented Modeling, Taxonomy of Quality Attributes, Perspectives of Quality, Quality System, Software Quality Assurance, Capability Maturity Model Observation on Estimation, The Project Planning Process, Software Scope and Feasibility, Human Resources, Empirical Estimation Model ,Introduction To DevOps, Cloud Computing And Virtualization, Migration to DevOps, DevOps Tools.

References:

1. R. Pressman, *Software Engineering: A Practitioners Approach*, (8e), McGrawHill Pubs, 2019.
2. M. Walls, *Building a Dev Ops Culture*, O'Reilly Publications, 2013.
3. J. Joyner, *Dev Ops for Beginners, Dev Ops Software Development Method guide for software developers and IT professionals,* Mihails Konoplovs, 2015.

CS3202: INFORMATION SYSTEMS SECURITY [3 1 0 4]

Introduction: Basic objectives of cryptography, Secret-key and public-key cryptography, One-way trapdoor one-way functions, Cryptanalysis, Attack models, Classical cryptography. Block ciphers: Modes of operation, DES and its variants, AES, Linear and differential cryptanalysis. Message digest: Properties of hash functions, MD2, MD5 and SHA-1, Keyed hash functions, Attacks on hash functions. Public-key parameters: Modular arithmetic, Primality testing, Chinese remainder theorem, Modular square roots, Finite field. Intractable problems: Integer factorization problem, RSA problem, Modular square root problem, Discrete logarithm problem, Diffie-Hellman problem, Known algorithms for solving the intractable problems. Public-key encryption: RSA, Rabin and EIGamal schemes, Elliptic and hyper-elliptic curve cryptography, Side channel attacks, Diffie-Hellman and MQV key exchange. Digital signatures: RSA, DSA and NR signature schemes, blind and undeniable signatures. Entity authentication: Passwords, Challenge-response algorithms, Zero-knowledge protocols. Network security: Certification, public-key infrastructure (PKI), secure socket layer (SSL), Kerberos.

References:

1. B. A. Forouzan, D. Mukhopadhyay, Cryptography and Network Security, (2e), Mc-Graw Hill, , 2008.
2. W. Stallings, Cryptography and Network Security: Principles and Practice, (5e),Prentice Hall, 2010.
3. J. Pieprzyk, T. Hardjono, J. Seberry, Fundamentals of Computer Security, Springer International Edition, 2003.
4. A. J. Menezes, P. C. V. Oorschot ,S. A. Vanstone, Handbook of Applied Cryptography, CRC Press.

CS3203: DATA SCIENCE AND MACHINE LEARNING [3 0 0 3]

Data Science: Descriptive Statistics, Probability Distribution, regression analysis, ANOVA. Machine Learning: Goals, Applications of ML, developing a learning system, training data, concept representation, function approximation. Decision Tree Learning: Representing concepts as decision trees, Recursive induction of decision trees, best splitting

attribute, entropy, information gain., Occam's razor, Overfitting, noisy data, and pruning. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units, Perceptron, representational limitation and gradient descent training, Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations, Overfitting, learning network structure, recurrent networks. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing. Support Vector Machines: Maximum margin linear separators. Kernels for learning non-linear functions. Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm, Logistic regression, Bayes nets and Markov nets for representing dependencies. Instance-Based Learning: k-Nearest-neighbor algorithm, Case-based learning, Relevance feedback and Rocchio algorithm. Naive Bayes for text. Clustering and Unsupervised Learning: Hierarchical Agglomerative Clustering, k-means partitioned clustering, expectation maximization (EM) for soft clustering. Ensemble Learning: Bagging, boosting, and Decorate. Active learning with ensembles.

References:

1. G. James, D. Witten, T Hastie, R Tibshirani, *An introduction to statistical learning with applications in R,* Springer, 2013.
2. J. Han, M. Kamber, J. Pei, *Data Mining concepts and techniques, (2e),* Morgan Kaufmann- Elsevier, 2011.
3. T. Hastie, R. Tibshirani, J. Friedman, *The Elements of Statistical Learning*, (2e), Springer, 2009.
4. K. Murphy, *Machine Learning: A Probabilistic Perspective,* MIT Press, 2012.
5. T. M. Mitchell, *Machine Learning*, (Indian Edition), MacGraw Hill, 2017.
6. C. Bishop, *Neural Networks for Pattern Recognition*, Oxford University Press, 2019

CS3230: SOFTWARE ENGINEERING LAB [0 0 2 1]

Introduction: Agile development: Agile Process Models Software, Communication Practice, Planning Practices, Modeling Practices, Construction Practice, Deployment of Computer–Based Systems, The System Engineering Hierarchy. Business Process Engineering: An Overview, Product Engineering: An Overview, Data Modeling Concepts, Object Oriented Analysis, Flow-Oriented Modeling, Taxonomy of Quality Attributes, Perspectives of Quality, Quality System, Software Quality Assurance, Capability Maturity Model Observation on Estimation using Projects, The Project Planning Process, Software Scope and Feasibility, Human Resources, Empirical Estimation Model ,Introduction To DevOps, Cloud Computing And Virtualization, Migration to DevOps, DevOps Tools, All above will be facilitated using Software Projects assigned to the students.

References:

1. R. Pressman, *Software Engineering: A Practitioners Approach*, (8e), McGrawHill Pubs, 2019.
2. M. Walls, *Building a Dev Ops Culture*, O'Reilly Publications, 2013.
3. J. Joyner*, Dev Ops for Beginners, Dev Ops Software Development Method guide for software developers and IT professionals,* Mihails Konoplovs, 2015.

CS3231: INFORMATION SYSTEMS SECURITY LAB [0 0 2 1]

Substitution and Transposition Cipher Implementation: Caesar Cipher, Playfair Cipher, Hill Cipher, Vigenere Cipher, Rail fence. Symmetric and Asymmetric Cipher Implementation: DES, RSA, Diffie-Hellman, MD5, SHA-1. Signature Schemes Implementation: Digital Signature Standard, GnuPG API. Demonstration of secure data storage: Setup of honey pot and monitoring on network using KF sensors. Installation of rootkits. Wireless audit on an access point or a router, WEP and WPA (Net Stumbler). Intrusion detection system using snort.

References:

1. B. A. Forouzan, D. Mukhopadhyay, *Cryptography and Network Security,* (2e), Mc-Graw Hill, 2008.
2. W. Stallings, *Cryptography and Network Security: Principles and Practice*, (5e), Prentice Hall, 2010.
3. J. Pieprzyk, T. Hardjono, J. Seberry, *Fundamentals of Computer Security*, Springer, 2003.

CS3270: MINOR PROJECT [0 0 6 3]

In this course student has to select a project work based on a topic of interest. Periodically the supervisor will evaluate the implementation. This work, started in eighth semester of which, the student will be evaluated internally and externally.

SEVENTH SEMESTER

CS4170: INDUSTRIAL TRAINING [0 0 2 1]

In this course the student, undergo in reputed Private / Public Sector / Government organization / companies as industrial training for a duration of 4-6 weeks to be undergone by the student in the summer vacation of the VI semester.

Outcome of this course:

To expose students to the 'real' working environment and be acquainted with the organization structure, business operations and administrative functions.

To have hands-on experience in the students' related field so that they can relate and reinforce what has been taught at the university.

To promote cooperation and to develop synergetic collaboration between industry and the university in promoting a knowledgeable society & to set the stage for future recruitment by potential employers.

EIGHT SEMESTER

CS4270: MAJOR PROJECT [0 0 24 12]

In this course student has to select a project work based on a topic of interest. Periodically the supervisor will evaluate the implementation. This work, started in eighth semester of which, the student will be evaluated internally and externally.

Outcome of the course:

Investigating professional topics, including ethical, legal and security issues, related to computing projects.

Design and Develop the software with Software Engineering practices and standards

Apply prior knowledge to design and implement solutions for computational problems while considering numerous realistic restraints.

PROGRAM ELECTIVES-II, III, IV

CS3140: INFORMATION CODING [3 0 0 3]

Information Theory: Entropy, Characterization and related properties, Huffman codes, Shannon-Fano coding, Robustness of coding techniques, Information measure-noiseless coding, Discrete memoryless channel, Channel capacity, Fundamental theorem of information theory. Coding Theory: Error correcting codes, Minimum distance principles, Hamming bound, General binary code, Group code, Linear group code. Convolution Encoding: Algebraic structure, Gilbert bound, Threshold decoding, Threshold decoding for block codes. Cyclic binary codes: BCH codes, Generalized BCH code and decoding, Optimum codes, Concepts of non-cyclic codes. Combinatorial Designs: Definitions of BIBD, Hadamard Designs, Latin Squares, Mutually Orthogonal Latin Squares, Orthogonal Arrays. Network Coding: Fundamentals of Network Coding, Butterfly networks, Graphs and networks, Max-flow min-cut theorem, Multi-source multicast problem, Deterministic code design for network coding, Randomized network coding, Application of network coding.

References:

1. T. M. Cover, J.A. Thomas, *Elements of Information Theory*, Wiley, (2e), 2006.
2. M. Kelbert, Y. Suhov, *Information Theory and Coding by Example*, Cambridge University Press, 2013.
3. D. Stinson, *Combinatorial Designs: Constructions and Analysis*, Springer, 2003.
4. P. J. Cameron , J. H. Lint, Designs, *Graphs, Codes and their Links*, Cambridge University Press, 2010.

CS3240: PRINCIPLES OF SECURE PROGRAMMING [3 0 0 3]

Introduction: Security goals, Secure system design, Secure design principles, Worms and other malware. Secure Programming Techniques: Anatomy of a buffer overflow, Safe string libraries, Stackguard, Static analysis tools, Heap-based overflow, Other memory corruption vulnerabilities, SQL Injection attack scenario and solutions, Password security. Cross-Domain Security in Web Applications: Interaction between webpages from different domains, Attack patterns, preventing cross-site request forgery, Cross-site script inclusion, Cross-site scripting. Other Web

Vulnerabilities: Cookie protocol problems, SSL/TLS vulnerabilities, Session hijacking, Guninski attack, Defenses. Trusted Execution Environment: Case study on TrustZone, Security vulnerability tools, Exploit development with metasploit.

References:

1. N. Daswani, C. Kern, A. Kesavan, *Foundations of Security, What Every Programmer Needs to Know*, Apress, 2007.
2. J. C. Foster, V. T. Liu, *Writing Security Tools and Exploits*, Syngress Publishing, 2006.
3. J. Ericson, *Hacking: The Art of Exploitation*, (2e), No Starch Press, 2008.
4. C. Anley, J. Heasman, F. Linder, G. Richarte, *The Shellcoder's Handbook: Discovering and Exploiting Security Holes*, (2e), Addison-Wiley, 2011.

CS4140: CYBER SECURITY [3 0 0 3]

Introduction to cyber security: Computer Security, threats, harm, vulnerabilities, controls, Authentication, Access Control and Cryptography, Web User Side, Browser Attacks, Web Attacks Targeting Users, Email Attacks. Security in operating system and networks: Security in Operating Systems, Security in the Design of Operating Systems, Rootkit, Network security attack, Threats to Network Communications, Wireless Network Security, Denial of Service, Distributed Denial-of Service. Security Countermeasures: Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Network Management, Databases, Security Requirements of Databases Reliability and Integrity, Database Disclosure, Data Mining and Big Data. Privacy in Cyberspace: Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, Email Security. Cyber Policies: Policies to mitigate cyber risks, Reducing Supply Chain Risks, Mitigate Risks through Human Resource Development, Information sharing Implementing a Cyber security framework, Digital Signature.

References:

1. M.S. Merkov, J. Breithaupt, *Information Security: Principles & Practices*, (2e), Pearson, 2014.
2. C.P. Pfleeger, S.L. Pfleeger, J. Margulies, *Security in Computing*, (5e), Pearson, 2015.
3. V. Sood, *Cyber Laws Simplified*, (2e) McGraw Hill, 2017.
4. N. Godbole, *Information Systems Security*, (2e), Wiley, 2017.

CS4141: DIGITAL FORENSICS & CYBER CRIMES [3 0 0 3]

Introduction to Computer Forensics: Computer crimes, evidence, extraction, preservation, overview of hardware and operating systems, structure of storage media/devices, uncovering attacks that evade detection by event viewer, task manager, and other Windows GUI tools, data acquisition, disk imaging, recovering swap files, temporary and cache files. Computer Forensic tools: Encase, Helix, FTK, Autopsy, Sleuth kit Forensic Browser, FIRE, Found stone Forensic ToolKit, WinHex, Linux and other open source tools. Mobile and Network Forensics: Collecting and analyzing network-based evidence, reconstructing web browsing, email activity, and windows registry changes, intrusion detection, tracking offenders, Mobile Network Technology, Investigations, Collecting Evidence, Interpretation of Digital Evidence on Mobile Network. Software Reverse Engineering: Defend against software targets for viruses, worms and other malware, improving third-party software library, identifying hostile codes-buffer overflow, provision of unexpected inputs. Computer crime and Legal issues: Intellectual property, privacy issues, Criminal Justice system for forensic, audit/investigative situations and digital crime scene, investigative procedure/standards for extraction, preservation, and deposition of legal evidence in a court of law.

References:

1. C. Altheide, H. Carvey, *Digital Forensics with Open Source Tools*, Syngress, 2011.
2. M.T. Britz, *Computer Forensics and Cyber Crime: An Introduction*, (3e), Kindle Edition, 2013.
3. S. Davidoff, J. Ham, *Network Forensics: Tracking Hackers through Cyberspace*, Prentice Hall, 2012.
4. B. Nelson, A. Phillips, F. Enfinger, C. Steua, *Guide to Computer Forensics and Investigations*, Thomson, (4e), 2009.

CS3141: CLOUD COMPUTING AND VIRTUALIZATION [3 0 0 3]

Introduction: Distributed Computing and Enabling Technologies, Cloud Fundamentals: Cloud Definition, Evolution, Architecture, Applications, deployment models, and service models. Virtualization: Issues with virtualization, virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, virtualization of data centers, and Issues with Multi-tenancy. Implementation: Study of Cloud Computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Build Private/Hybrid Cloud using open source tools, Deployment

of Web Services from Inside and Outside a Cloud Architecture. MapReduce and its extensions to Cloud Computing, HDFS, and GFS. Interoperability and Service Monitoring: Issues with interoperability, Vendor lock-in, Interoperability approaches. SLA Management, Metering Issues, and Report generation. Resource Management and Load Balancing: Distributed Management of Virtual Infrastructures, Server consolidation, Dynamic provisioning and resource management, Resource Optimization, Resource dynamic reconfiguration, Scheduling Techniques for Advance Reservation, Capacity Management to meet SLA Requirements, and Load Balancing, various load balancing techniques. Migration and Fault Tolerance: Broad Aspects of Migration into Cloud, Migration of virtual Machines and techniques. Fault Tolerance Mechanisms. Advances: Grid of Clouds, Green Cloud, Mobile Cloud Computing.

References:

1. R. Buyya, J. Broberg, A. Goscinski , *Cloud Computing Principles and Paradigms* , Wiley Publishers, 2013.
2. B. Sosinsky, *Cloud Computing Bible*, Wiley, 2011.
3. M. Miller, *Cloud Computing: Web-based Applications that change the way you work and collaborate online*, Pearson, 2008.
4. D. S. Linthicum, *Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide*, Addision Wesley Information Technology Series, 2010.
5. T. Velte, A. T. Velte, R. Elsenpeter, Cloud *Computing: A Practical Approach*, McGraw Hill, 2017.

CS3241: CLOUD INFRASTRUCTURE AND SERVICES [3 0 0 3]

Introduction: Clouds and Cloud Computing: Basic Concepts, Types of Services, deployment models. Classic Data Center (CDC): DBMS concepts, CDC drawbacks, CDC Management and case studies. Virtualized Data Center (VDC): Compute virtualization overview, Compute virtualization techniques, Virtual Machines, VM Resource management techniques, Virtual Infrastructure Requirements. Storage: Storage virtualization overview, Virtual Machine Storage, Virtual provisioning and automated storage tiering. Networking: VDC networking overview, VDC networking components, VLAN and VSAN technologies. Business Continuity in VDC, Fault tolerance mechanism in VDC. Cloud Security: Access control and identity management in Cloud, Governance, risk, and compliance, Security best practices for Cloud, Cloud Migration. Issues in Cloud Development: Migration etc.

References:

1. B. Jackson, K. Saurabh, *Cloud Computing*, (2e), Wiley India, 2012.
2. V. Joysula, M. Orr, G. Page, *Cloud Computing: Automating the Virtualized Data Center*, Cisco Press, 2012.
3. R. K. Buyya, *Cloud Computing: Principles and Paradigms*, Wiley Press, 2011.
4. M. Miller, *Cloud Computing*, (8e), Que Publishers, 2008.
5. Course materials from *EMC² Education Services*

CS4142: CLOUD COMPUTING APPLICATIONS [3 0 0 3]

Cloud Based Applications: Introduction, Contrast traditional software development and development for the cloud. Public v private cloud apps. Understanding Cloud ecosystems – what is SaaS/PaaS, popular APIs, mobile; Desktop and Application: Cloud Application Architectures, Desktop virtualization, Application virtualization, Web Application design, Cloud app, Benefits of cloud apps, cloud API, Cloud apps vs. web apps, Cloud apps vs. desktop apps, Testing of cloud apps; Designing Code for the cloud: Class and Method design to make best use of the Cloud infrastructure; Web Browsers and the Presentation Layer- Understanding Web browsers attributes and differences. Building blocks of the presentation layer: HTML, HTML5, CSS, Silverlight, and Flash. Web Development Techniques and Frameworks: Building Ajax controls, introduction to Javascript using JQuery, working with JSON, XML, REST. Application development Frameworks e.g. Ruby on Rails, .Net, Java API's or JSF; Deployment Environments – Platform As A Service (PAAS),Amazon, vmForce, Google App Engine, Azure, Heroku, AppForce; Cloud Application Performance Mangaement: Managing applications in the cloud, cloud application migration, Resource vs. application performance , Private and public instances, Topology discovery, First generation CAPM tools and problems, Second generation CAPM tools and advantages, Cloud application performance components, Agents and applications, Internet as part of the infrastructure, Hosted SaaS CAPM advantages, Root cause analysis challenges, case studies.

References:

1. G. Reese, *Cloud Application Architectures*, O'Reilly Media, Inc, 2009.
2. E. Pace, D. Betts, S. Densmore, R. Dunn, M. Narumoto, *Developing Applications for the Cloud on the Microsoft Windows Azure Platform*, Microsoft Press, 2010.

3. V. Joysula, M. Orr, G. Page, *Cloud Computing: Automating the Virtualized Data Center*, Cisco Press, 2012.
4. Mei- Ling Liu, *Distributed Computing: Principles and Application*, Pearson, Education, Inc. New Delhi. 2004

CS4143: CLOUD SECURITY AND PRIVACY [3 0 0 3]

Introduction: Cloud Computing Defined, The SaaS, PaaS and IaaS (SPI) Framework for Cloud Computing, Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise. Security: Infrastructure Security: Network, Host and Application. Data Security and Storage: Aspects and Mitigation, Provider Data and Its Security. Identity and Access Management (IAM): Trust Boundaries, IAM Challenges, Definitions, Architecture and Practices, IAM Standards and Protocols for Cloud Services, Cloud Authorization Management. Security Management: Security Management Standards, Security Management in the Cloud, Availability Management: SaaS Availability Management, PaaS Availability Management, IaaS Availability Management, Access Control, Security Vulnerability, Patch, and Configuration Management. Privacy: Privacy Standards, Data Life Cycle, Key Privacy Concerns in the Cloud, Legal and Regulatory Implications. Cloud Morphing: Shaping the Future of Cloud Computing Security and Auditing the Cloud for Compliance. Audit and Compliance: Internal Policy Compliance, Governance, Risk, and Compliance, Illustrative Control Objectives for Cloud Computing, Incremental CSP-Specific Control Objectives, Additional Key Management Control Objectives, Control Considerations for CSP Users, Regulatory/External Compliance Cloud Security Alliance, Auditing the Cloud for Compliance.

References:

1. S. Pearson , G. Yee , Privacy and Security for Cloud Computing, Springer, 2013.
2. T. Mather, Subra Kumaraswamy, Shahed Latif*, Cloud Security and Privacy, O'Reilly Media, 2009.*
3. B. Halpert, *Auditing Cloud Computing: A Security and Privacy Guide*, Wiley, 2011.
4. K. Saurabh, *Cloud Computing*, (2e), Wiley, 2012.

CS4144: INFORMATION RETRIEVAL [3 0 0 3]

Introduction to IR: IR Concepts, Boolean Retrievals- An Example Information Retrieval Problem, A First Take at Building an Inverted Index, Processing Boolean Queries. The Term Vocabulary and Postings Lists: Document Delineation and Character Sequence Decoding, Determining the Vocabulary of Terms. Dictionaries and Tolerant Retrieval: Search Structures for Dictionaries, Wildcard Queries, Spelling Correction, Phonetic Correction. Index Construction: Hardware Basics Blocked Sort-Based Indexing. Scoring, Term Weighting and the Vector Space Model: Parametric and Zone Indexes, Term Frequency and Weighting, The Vector Space Model for Scoring. Evaluation in Information Retrieval: Information Retrieval System Evaluation, Standard Test Collections, Evaluation of Unranked Retrieval Sets, Evaluation of Ranked Retrieval Results. XML Retrieval: Basic XML Concepts, Challenges in XML Retrieval, A Vector Space Model for XML Retrieval, Evaluation of XML Retrieval, Text-Centric vs. Data-Centric XML Retrieval. Web Search Basics: Web Characteristics, Advertising as the Economic Model, The Search User Experience, Index Size and Estimation, Near-Duplicates and Shingling. Web Crawling and Indexes: Overview, Crawling, Distributing Indexes, Connectivity Servers. Link Analysis: The Web as a Graph, Page Rank, Hubs and Authorities.

References:

1. C. Manning, P. Raghavan, H. Schütze, *Introduction to Information Retrieval,* Cambridge University Press, 2009.
2. R. Baeza-Yate, B. Ribeiro-Neto, *Modern Information Retrieval,* (2e), Addison Wesley, 2012.
3. S. Chakrabarti, *Mining the Web: discovering knowledge from hypertext data,* (2e), Morgan Kaufmann, 2002.
4. D. A. Grossman , O. Frieder, *Information Retrieval: Algorithms, and Heuristics, (2e)*, Springer, 2004.

CS4145: COMPUTER GRAPHICS & MULTIMEDIA [3 0 0 3]

Basics of Computer Graphics: Pixel, Frame buffer, Application of computer graphics. Graphic Display Devices: Cathode Ray Tube, Light emitting diode, DVST, Random and Raster Scan displays. Scan Conversion: Line Generation using digital differential analyzer (DDA), bresenham's Algorithm, Circle generation algorithm, Ellipse generation algorithm, Polygon generation and filling algorithms. Two Dimensional Transformations: Introduction, homogeneous representation of points, basic transformation like Translation, Rotation, Scaling, Reflection, Shear. Clipping and Windowing: Cohen Sutherland Algorithm, liang Barsky algorithm, Sutherland Hodgman Algorithm. Three dimensional transformation: Translation, Rotation, Scaling and Reflection. Projection: Introduction, Types of projection. Hidden Surface elimination: Depth comparison, Back face detection algorithm, Painter's Algorithm, Z-Buffer Algorithm. Basic Illumination Model: Diffuse reflection, Specular reflection, Phong and Gouraud shading.

Introduction to Multimedia: Concepts and uses, hypertext and hypermedia, image, video and audio standards, text compression algorithm. Animation: types, techniques, key frame animation, utility, morphing.

References:

1. D. Hearn, M. P. Baker, *Computer Graphics with OpenGL*, (4e), Pearson Education, 2014.
2. R. Steinmetz, K. Nahrstedt, *Multimedia Systems*, Springer, 2004
3. J. F. Hughes, J. D. Foley, *Computer graphics Principles and Practice*,(3e), Pearson Education, 2014.
4. R. Steinmetz, K. Nahrstedt, *Multimedia Fundamentals: Media Coding and Content Processing*, (2e), Pearson Education, 2004

CS4146: USER INTERFACE DESIGN [3 0 0 3]

UI Design Process: Design Process Introduction, Designing to Address a Problem w/o Solution Ideas, Designing for a known solution direction, Designing to iterate on/improve an existing solution, Common Elements: Usability, Engineering and Task-Centered Approaches, Use Cases, Personas, Tasks, and Scenarios, Design-Centered Methods & When They Work Best, Pulling it all Together, Psychology and Human Factors for User Interface Design: Introduction, Fitts' Law, Short- and long-term memory, attention, Perception and visualization, hierarchy, Mistakes, Errors, and Slips, Conceptual models, The Gulf of Execution and the Gulf of Evaluation, Design Principles: Visibility, Feedback, Mappings, Constraints, Interacting beyond individuals (social psychology), High-Level Models: Distributed Cognition, Activity Theory, Situated Action, User Research Methods: User Research to Design, Introduction to User Research, Interview and Focus Groups, Observations, Contextual Inquiry, Ethics and Consent, Design a User Research Protocol, Log Analysis, Surveys and Questionnaires, Analyzing and Delivering User Research: Introduction: Translating User Research to Support Design, Qualitative Analysis, Quantitative Analysis, Personas I: What They Are; How They're Used, Personas II: Walking Through Examples, Use Cases, Tasks and Walkthrough Scenarios, Implications for Design, Ideation and Idea Selection: rom Research to Ideas, Ideation, Idea Selection, Communicating Ideas to Stakeholders, Good User Interfaces principles: learnability, visibility, error prevention, efficiency, and graphic design) and the human capabilities that motivate them (including perception, motor skills, color vision, attention, and human error), Implementation of UI: building user interfaces, including low-fidelity prototypes, etc Empirical research involving novel user interfaces.

References:

1. Norman, A. Donald, *The Design of Everyday Things.* MIT Press, 2014.
2. Coursera platform and internet resources

CS4147: DIGITAL IMAGE PROCESSING [3 0 0 3]

Introduction to image processing: steps in image processing, Image file formats, Basic relationships between pixels, Colour Models. Image Enhancement and Restoration: Image histogram, Spatial domain enhancement, point operations, Log transformation, Power-law transformation. Frequency domain enhancement: introduction to image transforms, Fourier transform, 2D-DFT. Restoration: Noise models, Restoration using Inverse filtering and Wiener filtering. Image Coding and Compression: Lossless compression, Lossy compression, JPEG, MPEG. Image Segmentation and Representation: Grey level features, edges and lines, similarity, correlation, template matching, edge detection using templates, Representation scheme, boundary descriptors, regional descriptors, Image Morphology. Biometric Authentication, Object Detection.

References:

1. K. R. Castleman, *Digital Image Processing*, (2e), Pearson Education, 2011.
2. R. C. Gonzalez, R. E. Woods, *Digital Image Processing*, (4e), Pearson Education, 2018.
3. A. K. Jain, *Fundamentals of Digital Image Processing*, Pearson Education, Reprint 2015.
4. S. Jayaraman, S. Esakkirajan, T Veerakumar, *Digital Image Processing*, Tata McGraw Hill Education, 2009.
5. R. C. Gonzalez, R. E. Woods, S. Eddins, *Digital Image Processing using MATLAB*, (2e), Pearson Education.
6. A. McAndrew, *Introduction to Image processing using MATLAB*, Cengage Learning Publisher, 2007.
7. Prateek Joshi, *OpenCV with Python By Example,* (1e) PACKT Publishing, 2018.

CS4148: INTERNET OF THINGS [3 0 0 3]

Introduction: Analog and digital signals, serial communication, RF and sensors; Introduction to JSON/XML. Programming on Development Boards: Understanding of the board, tool chain and development environment setup; Sensors and Actuators: Understanding and using analog, digital, SPI, UART, I2C. Nodes and communication protocols: Understanding usage of nodes and gateways for sensor communication and external communication, RF, Zigbee,

BT, WI-FI, GSM. IoT Cloud Platform, Cloud using Web Services, Cloud Computing Services for Sensor Management, Python Script; Data Analytics: Mongo DB, Map Reduce, Using cloud APIs for analytics, Visualization, NVD3, Mobile interfacing.

References:

1. V. Madisetti, A. Bahga, *Internet of Things: A Hands-On- Approach*, VPT, 2014.
2. R. Buyya, A. V. Dastjerdi, *Internet of Things Principles and Paradigms*, 2016.
3. H. Geng*, Internet of Things Principles and Data Analytics Handbook*, Wiley, 2017.
4. P. Raj, A. C. Raman, *The Internet of Things Enabling Technologies, Platforms, and Use Cases*, CRC Press, 2017.

CS4149: BIG DATA ANALYTICS [2 0 1 3]

INTRODUCTION: Introduction to big data, definition, need and evolution of BDA, Applications of Big Data. Analysing big data: Sources of big data, Characteristics of Big Data(4 V's), Drivers of BDA, Structured vs. Unstructured data, Data Marts, Differences between traditional DWDM and BDA. Data Processing: Data Wrangling, Data Munging, Data Jujitsu. Data Visualisation: Why to visualize data. Data Analytics Life Cycle. Advanced Analytics Algorithms: Introduction using R – Theory and Methods Overview: K-means clustering, Association Rules, Linear Regression, Logistic Regression, Naïve Bayesian Classifiers, Decision Trees, Time Series Analysis, Text Analytics; Statistics for Model Building and Evaluation: Statistics in the Analytic Lifecycle, Hypothesis Testing, Difference of means. Hadoop Framework: Introduction to Hadoop, HDFS - Hadoop Distributed File system, Map Reduce Programming, Pig. ETL & Batch Processing with Hadoop: ETL & Data Warehousing, Ingesting data into Big Data Platforms using Apache Sqoop & Flume, Big Data Analytics using Apache Hive, NoSQL databases for Big Data Storage Applications (HBase), Workflow management for Hadoop using Oozie Spark: Introduction to Spark, SparkSQL, MLLib: Regression, Clustering & Classification using Spark MLLib.

References:

1. B. Schmarzo, *Big Data: Understanding How Data Powers Big Business,* Wiley.2013
2. A. Jorgensen, J. Rowland-Jones, J. Welch, *Microsoft Big Data Solutions,* Wiley.,2014
3. J. Thompson, S. P. Rogers, *Analytics: How to Win with Intelligence, Technics, LLC Publications,* 2017

CS4150: SOFTWARE DEFINED NETWORKS [3 0 0 3]

Software Defined Networking (SDN): Separation of control plane and data plane, IETF forces, Active networking. Control and Data Plane Separation: Concepts, Advantages and disadvantages, the Open flow protocol. Control Plane: Overview, Existing SDN controllers including floodlight and open daylight projects. Customization of Control Plane: Switching and firewall implementation using SDN concepts. Data Plane: Software-based and Hardware-based, Programmable network, Mininet based examples. Programming SDNs: Northbound application programming interface, current languages and tools, Composition of SDNs. Network Functions Virtualization (NFV): Concepts, Implementation, Applications. Use Cases of SDNs: Data Centers, Internet exchange points, Backbone networks, Home networks, Traffic engineering. Programming Assignments for implementing some of the theoretical concepts listed above.

References:

1.T. D. Nadeau, K. Gray, *SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies,* (1e) O'Reilly Media, 2013.

2.P. Goransson, C. Black, *Software Defined Networks: A Comprehensive Approach,* (2e) Morgan Kaufmann, 2016.

3.F. Hu, *Network Innovation through Open Flow and SDN: Principles and Design*, CRC Press, 2014.

4.V. Tiwari, *SDN and Open Flow for Beginners, Amazon Digital Services, Inc.,* ASIN, 2013.

5.S Subramanian, *Software Defined Networking with OpenStack,* Packt Publishing, 2016.

CS4151: DEEP NEURAL NETWORK [3 0 0 0]

Introduction of Deep Learning, Basics of Machine Learning, Neural Network, Activation function, Gradient Descent, Stochastic Gradient Descent, backpropagation, Deep Convolution Neural network: convolution operation, ReLU Layer, Pooling Layer, Flattening, fully connected layer, softmax and cross entropy, Recurrent Neural network: Vanishing Gradient Problem, LSTMs, LSTM variations, Self-organizing Map (SOM), K-means clustering, Boltzmann Machine, Energy-based Models, Contrastive Divergence, Deep Belief Networks, autoencoders, training of auto encode, over complete hidden layers, sparse autoencoders, denoising autoencoders, contractive autoencoders, stacked autoencoders, deep autoencoders.

References:

1. I. Goodfellow, Y. Bengio , A. Courville, *Deep Learning*, MIT Press 2016.
2. S. Haykin, *Neural Networks and Learning Machines*, (3e), PHI, 2008.

CS4152: SOCIAL NETWORK ANALYSIS [2 0 1 3]

Introduction to Social Web: Nodes, Edges and Network measures, Describing Nodes and Edges, Describing Networks, Layouts. Visualizing Network features: The role of Tie Strength, Measuring Tie Strength, Tie Strength and Network Structure, Tie Strength and Network Propagation, Link Prediction, Entity Resolution. Link Prediction: Case Study Friend recommendation. Communities: Introduction, Communities in Context, Quality Functions. Algorithms: Clustering-based, Newman and Girvan- Divisive clustering, Newman-Modularity maximization, Clauset-Greedy optimization of modularity, Louvain Method-Hierarchical clustering, Agglomerative clustering, Falkowski(DENGRAPH)-Density-based clustering, Nikolaev-Entropy centrality-based clustering, Clique-based Methods for Overlapping Community Detection, Palla- Clique percolation method, Lancichinetti-Fitness function, Du-Kernels-based clustering, Shen-Agglomerative hierarchical clustering, Evans-Line graph, clique graph, Label Propagation-based Community Detection. Introduction to Social Influence: Influence Related Statistics, Social Similarity and Influence, Homophile, Existential Test for Social Influence, Influence and Actions, Influence and Interaction, Influence Maximization in Viral Marketing.

References:

1. J. Goldbeck, *Analyzing the Social Web*, Morgan Kaufmann Publications, 2013.
2. C. C. Aggarwal, *Social Network Data Analytics*, Springer Publications, 2011.
3. J. Scott, *Social Network Analysis*, (3e), SAGE Publications Limited, 2013.
4. J. Goldman, *Facebook Cookbook*, O'Reilly, 2009.
5. S. Kumar, F. Morstatter, H. Liu, *Twitter Data Analytics*, Springer Publications, 2013.

CS4153: SOFTWARE TESTING [3 0 0 3]

Introduction and concept learning: Basic definitions, Testing axioms, Purpose of Software Testing, Software Testing Principles, The Tester's Role in a Software Development Organization, Origins of Defects, Cost of defects, Defect Classes, Defect Prevention strategies, Defect Repository, Strategies for Software Testing, Testing Activities, Mistakes, Faults & Failures, Verification and Formal Methods, Planning for Verification and Validation. White-Box Testing: Test Adequacy Criteria, Static Testing, Structural Testing, Code Complexity Testing, Mutation Testing, Data Flow Testing. Black-Box Testing: Test Case Design Criteria, Requirement Based Testing, Positive and Negative Testing, Boundary Value Analysis, Equivalence Partitioning State Based Testing, Domain Testing. Functional Testing: Test Plan, Test Management, Test Execution and Reporting, Test Specialist Skills, Tester's Workbench and Tool Categories, Debugging, Test Bed, Traceability and Testability, Attributes of Testable Requirements, Test Matrix, Types of Testing Documentation, Verification Testing, Validation Testing, Integration Testing, System and Acceptance Testing, GUI Testing, Regression Testing, Selection, Minimization and Prioritization of Test Cases for Regression Testing, Creating Test Cases from Requirements and Use cases, Test Design. Test Automation: Software test automation – skill needed for automation – scope of automation – design and architecture for automation – requirements for a test tool – challenges in automation – Test metrics and measurements – project, progress and productivity metrics.

References:

1. W. E. Perry, *Effective Methods for Software Testing,* John Wiley and Sons, 2000.
2. R. Patton, *Software Testing*, Sams Publishing, 2005.
3. A. P. Mathur, *Foundations of Software Testing*, Pearson Education, 2013.
4. J. L. Mitchell, R. Black, *Advanced Software Testing—Vol. 3*, Rocky Nook, 2015.

CS4154: LINUX SYSTEM AND SHELL PROGRAMMING [3 0 0 3]

Fundamentals: Processes in Linux, I/O system calls, select and poll functions, Filters and redirection, Linux file system navigation, Directory access, File system implementation, Hard links and symbolic links. Asynchronous Events: Manipulating signal masks and signal sets, Catching and ignoring signals, Waiting for signals. Inter-Process Communication: Sockets, Remote procedure calls, Network file system. Concurrency: POSIX thread attributes, Synchronization functions, Mutex locks, Condition variables, Signal handling and threads. Character Device Driver Development: Driver concepts, Writing character drivers, Interrupt handling, Interfacing with hardware. Shell Scripting: Loops, Conditional statements, Command line arguments, test command, expr command. Advanced

Scripting Techniques: Providing command line options to scripts, Exporting variables, Arrays, Remote shell execution, Connecting to MySQL using shell, Essential system administration.

References:

1. W. R. Stevens, S. A. Rago, *Advanced Programming in the UNIX Environment*, (3e), Addison-Wesley, 2013.
2. R. Love, *Linux System Programming: Talking Directly to the Kernel and C Library,* O'Reilly, 2007.
3. S. Das*, Unix Concepts and Applications*, (4e), McGraw Hill, 2006.
4. W. R. Stevens, B. Fenner, *UNIX Network Programming, Volume 1: The Sockets Networking API,* (3e), Pearson, 2003.
5. K. A. Robbins, S. Robbins, *Unix Systems Programming: Communication, Concurrency, and Threads*, (2e), Prentice Hall, 2004.

CS4155: WIRELESS SENSOR & ADHOC NETWORK [3 0 0 3]

Introduction to ad-hoc networks: Definition, characteristics features, applications. Characteristics of Wireless channel, Ad-hoc Mobility Models: Indoor and outdoor models. MAC Protocols: design issues, goals and classification. Contention based protocols with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN. Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing. Transport layer: Issues in designing- Transport layer classification, ad-hoc transport protocols. Security issues in ad-hoc networks: issues and challenges, network security attacks, secure routing protocols. Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary perspective. Integration of ad-hoc with Mobile IP networks. Mesh Networks, Vehicular Area Networks, and Mobile Ad Hoc Networks (MANETs). Introduction to sensor networks and its applications: Architecture and factors influencing the sensor network design. Routing protocols- data centric routing protocols, hierarchical routing protocols, location based routing, energy efficient routing etc. Node Scheduling and coverage issues, topology control. Querying, data collection and processing.

References:

1. S. K. Sarkar, T G Basavaraju, C Puttamadappa, *Ad Hoc Mobile Wireless Networks: Principles, Protocols, and Applications,* (2e), CRC Press, 2016.
2. C. D. Morais Cordeiro, D. P. Agrawal, *Ad Hoc and Sensor Networks: Theory and Applications,* (2e), World Scientific Publishing, 2011.
3. H. Karl, A. Willing, *Protocols and Architectures for Wireless Sensor Networks,* John Wiley & Sons, 2007.
4. R. Jurdak, *Wireless Ad Hoc and Sensor Networks: A Cross-Layer Design Perspective*, Springer Publications,2007.
5. S R Murthy, B. S. Manoj, *Ad Hoc Wireless Networks Architectures and Protocols,* Pearson Education, 2008.

CS4156: MOBILE COMPUTING [3 0 0 3]

Wireless Communication Fundamentals: Introduction wireless transmission, Frequencies for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, Modulations spread spectrum, MAC, SDMA, FDMA, TDMA, CDMA, Cellular wireless networks. Telecommunications Systems: GSM, System architecture protocols, Connection establishment, Frequency alocation, Routing, handover, Security, GPRS. Wireless Networks: Wireless LAN-IEEE 802.11 Standards, Architecture, Services HIPERLAN, AdHoc Network, Bluetooth mobile network layer: Mobile IP, Dynamic host configuration protocol. Routing: DSDV, DSR, Alternative metrics, Wireless application protocol. Mobile Ad hoc Networks: Overview, Properties of a MANET, Spectrum of MANET applications, Routing and various routing algorithms, Security in MANET.

References:

1. W. Stallings, *Wireless Communications and Networks,* (2e) Pearson Education, 2018.
2. J. Schiller, *Mobile Communications,* (2e), *Pearson Education*, 2009.
3. K. Garg, *Mobile Computing: Theory and Practice,* (1e) Pearson Education India, 2010.

CS4157: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Introduction: Ambiguity and uncertainty in language, processing paradigms, phases in natural language processing. Text representation in computers: encoding schemes. Linguistics resources: Introduction to corpus, elements in balanced corpus, WordNet, VerbNet. Part of Speech tagging: Stochastic POS tagging, HMM, Transformation based

tagging (TBL), handling of unknown words, named entities, multi word expressions. Natural language grammars: lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, context free grammar, spoken language syntax. Parsing- unification, probabilistic parsing, tree-bank. Semantics: meaning representation, semantic analysis, lexical semantics. Word Sense Disambiguation: selection restriction, machine learning approaches, dictionary based approaches. Discourse: Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Real time Applications of NLP: text to speech, text summarization, information retrieval, sentiment analysis, machine translation.

References:

1. D. Jurafsky, J. H. Martin, *Speech and Language Processing*, (2e), Pearson Education, 2009.
2. T. Siddiqui, U. S. Tiwary, *Natural language processing and Information retrieval,* Oxford University Press, 2008.

CS4158: COMPUTER VISION [3 0 0 3]

Introduction to computer vision and its applications, Geometric Image Features: Differential Geometry, Contour Geometry, analytical image features: Euclidean geometry, Geometric Camera Parameters, Calibration methods, Image formation, Liner Filtering: Linear filters and convolution, shift invariant linear systems, spatial frequency and Fourier transforms, Image transformations and Colour models, Edge Detection methods (Laplacian detectors and Canny edge detector), Points and patches, Harris corner detector, Histogram of Gradients, Difference of Gaussian detector, SIFT, Colour and Texture, Feature based alignment, least squares and RANSAC, Camera models, Camera calibration, Stereo vision, Stereo correspondence, Epipolar geometry Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense motion estimation, Support Vector Machines, Face detection and recognition, Bag of words, Deep convolution neural network.

References:

1. R. Szeliski, *Computer Vision: Algorithms and Applications*, Springer 2011.
2. D. A. Forsyth, J. Ponce, *Computer Vision: A Modern Approach*, (2e), PHI learning, 2012
3. J. E. Solem, *Programming Computer Vision with Python*, O'Reilly, 2012.

OPEN ELECTIVES

CS2080: FUNDAMENTAL OF DATABASES [3 0 0 3]

Introduction: Database-System Applications, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture. File Management System: Indexing and Hashing. Relational Algebra: Algebra, Tuple Calculus, Domain Calculus. SQL: Data Definition Language, Data manipulation language , SQL Data Types and Schemas, Integrity Constraints, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Null Values, Nested Sub-queries, Correlated queries. Join: Inner, Outer, Left, Right and Natural. The Entity-Relationship Model: Constraints, Entity-Relationship Diagrams, Entity-Relationship Design Issues, Weak Entity Sets, Extended E-R Features. Normalization: Normal Forms, BCNF.

References:

1. R. Elmasri, S. B. Navathe, *Fundamentals of Database Systems*, (6e), Addison-Wesley, 2010.
2. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.

CS3080: PRINCIPLES OF PROGRAMMING LANGUAGES [3 0 0 3]

Preliminary Concepts: Concepts of programming languages. Syntax and Semantics: general Problem of describing Syntax and Semantics. Data types: Primitive, character, user defined, array, associative record, union, pointer and reference types. Expressions and Statements: Assignment Statements, Control Structures. Subprograms and Blocks: Fundamentals of sub-programs, Scope of life time of variables, static and dynamic scope, design issues of sub-programs and operations. Abstract Data types: Abstractions and encapsulation, introductions to data abstraction, design issues, language examples. Concurrency: Subprogram level concurrency, semaphores, monitors, massage passing, Java threads, C# threads. Exception handling: Exceptions, exception Propagation, Exception handler in Ada, C++ and Java, Logic Programming Language: Introduction and overview of logic programming.

References:

1. R. W. Sebesta, *Concepts of Programming Languages*, (10e), Pearson Education, 2008.
2. D. A. Watt, *Programming Language Design Concepts*, Wiley, (2e), 2007.

3. B. Tucker, R. E. Noonan, *Programming Languages*, (2e), TMH, 2007.
4. K. C. Louden, *Programming Languages*, (2e), Thomson, 2003.
5. T. W. Pratt, M. V. Zelkowitz, T. V. Gopal, *Programming Languages: Design and Implementation*, (4e), PHI, 2006

CS3081: ENTERPRISE RESOURCE PLANNING [3 0 0 3]

ERP Overview: ERP Components, ERP Benefits. Business Process Reengineering (BPA): BPA life cycle, BPA components. Data warehousing, Datamining, Supply chain Management; ERP: evolution, a Manufacturing Perspective, ERP Module, ERP Market, ERP implementation life cycle, Options of various paradigms, Identification of suitable platforms. SDLC/SSAD: Role of SDLC/SSAD, Object oriented architecture. ERP Implementation: introduction, pre evaluation screening, package evaluation, project planning phase, Gap analysis, Hidden costs, Major Vendors, Consultant Employees, Human Resource. ERP & E-Commerce: Future Directives- in ERP, ERP and Internet, Critical Factors guiding selection and evaluation of ERP, Strategies for its successful implementation, Impediments and initiatives to achieve success, Critical success and failure factors, Integrating of ERP into organizational culture. Using ERP tool: Case study of a system using SAP or ORACLE or open source ERP.

References:

1. S. R. Magal, J. Word, *Integrated Business Processes with ERP Systems*, (2e), John Wiley & Sons, 2011.
2. M. Sumner, *Enterprise Resource Planning*, Pearson Education, (2e), 2006.
3. E. Monk, B. Wagner, *Concepts in Enterprise Resource Planning*, (3e), Thomson Course Technology, 2006.

CS3082: PRINCIPLES OF MACHINE LEARNING [3 0 0 3]

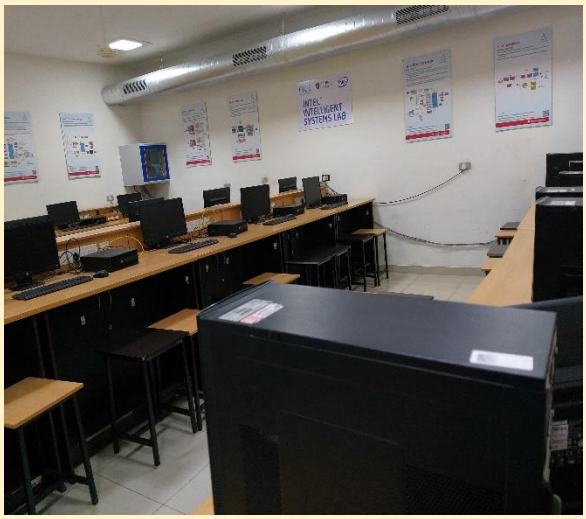
Introduction to Artificial Intelligence: Foundations, scope, problems. Problem-solving through Searching: forward and backward, state-space, blind, heuristic, problem-reduction, minimax. Supervised Learning: Process for feature selection, over-parameterization and the curse of dimensionality, regularization, cross validation. Classification: operation of classifiers, regression as a classifier, metrics used to evaluate classifiers, SVM, Naïve Bayes, KNN. Regression: operation of regression models, prediction and forecasting, metrics used to evaluate regression models. Neural networks: Feed forward NN, Feed backward NN, Convolutional Neural network. Unsupervised Learning: K-mean clustering. Algorithmic Learning Theory and Applications: Mistake bound model, PAC Model.

References:

1. G. F. Luger, W. A. Stubblefield, *Artificial Intelligence - Structures and Strategies for Complex Problem Solving.* (5e), Addison Wesley, 2005.
2. P Baldi, S Brunak, *Bioinformatics: A Machine Learning Approach,* (2e) MIT Press, 2002.
3. T. M. Mitchell, *Machine Learning,* McGraw-Hill Education, 2017.
4. Y Abu-Mostafa, M. Magdon-Ismail, H.T. Lin, H-T. *Learning from Data*. AML Book, 2012.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Department of Electronics & Communication Engineering is running B.Tech., M.Tech., and PhD Programs. B. Tech. programs offers a unique mix of Electrical, Electronics, Communication and Computer related courses that enable the student to choose a professional career and/or pursue higher studies in any of streams. M. Tech. Programs have a multi-disciplinary focus and are designed with the sole aim of developing the student's core competence, to take up the challenges in the field of design, research, innovations & development, as per industry and academia requirements. The department offers M.Tech Programs in two specialization: Communication Systems and VLSI & Embedded System Design. All the Labs are equipped with the latest hardware and software tools to support knowledge dissemination in the classroom and provide hands-on practical experience. The department has Digital Electronics Lab, Signals and Circuit Simulation Lab, Microprocessors/ Microcontrollers Lab, Electronic Circuits Lab, VLSI Lab, Digital Signal Processing Lab, Embedded System Design Lab, Communication Lab I & II, Semiconductor Fabrication Lab, PCB Design & Project Lab. In recent years, the department has embarked on R&D projects funded by DST, ISRO etc. MoU have been signed with CEERI Pilani, Forsk Technologies, Secure Meters, and CDAC Pune. The Department has research funding from ISRO, DST & other national funding agencies. The students have been placed in various companies related to ECE & IT sectors.



B.Tech in Electronics & Communication Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value Ethics & Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA2103	Engineering Mathematics – III	2	1	0	3	MA2205	Engineering Mathematics – IV	2	1	0	3
	EC2101	Signals & Systems	3	0	0	3	EC2201	Analog Integrated Circuits & Systems	3	0	0	3
	EC2102	Analog Electronics	3	1	0	4	EC2202	Microprocessors & Microcontrollers	3	1	0	4
	EC2103	Digital System Design & Computer Architecture	3	1	0	4	EC2203	Digital Signal Processing	3	1	0	4
	EC2104	Electromagnetic Field Theory	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	EC2130	Analog Electronics Lab	0	0	2	1	EC2230	Electronic Sub-System Design Lab	0	0	2	1
	EC2131	DSD & HDL Lab	0	0	2	1	EC2231	Digital Signal Processing Lab	0	0	2	1
	EC2170	Project Based Lab - I	0	0	2	1	EC2232	Microprocessors & Microcontrollers Lab	0	0	2	1
							EC2270	Project Based Lab - II	0	0	2	1
			16	4	6	23			17	3	8	24
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P) + OE		28			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	BB0026	Organisation and Management	2	1	0	3	EC3201	Microwave Engineering	3	0	0	3
	EC3101	Antennas	3	1	0	4	EC3202	Embedded & Real Time Operating Systems	3	1	0	4
	EC3102	Network & Control Theory	3	1	0	4	EC3203	Optical Communication	3	1	0	4
	EC3103	Analog & Digital Communication	3	1	0	4	EC32XX	Program Elective – I	3	0	0	3
	EC3104	CMOS VLSI Design	3	1	0	4	EC32XX	Program Elective – II	3	0	0	3
	XXXXXX	Open Elective – II	3	0	0	3	XXXXXX	Open Elective – III	3	0	0	3
	EC3130	VLSI Lab	0	0	2	1	EC3230	Embedded & RTOS Lab	0	0	2	1
	EC3131	Analog & Digital Communication Lab	0	0	2	1	EC3231	Antenna & Microwave Lab	0	0	2	1
	EC3170	Project Based Lab - III	0	0	2	1	EC3232	Optical Communication Lab	0	0	2	1
							EC3270	Minor Project-I	0	0	2	1
			17	5	6	25			18	2	8	24
	Total Contact Hours (L + T + P) + OE		28				Total Contact Hours (L + T + P) + OE		28			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	EC41XX	Program Elective – III	3	0	0	3	EC4270	Major Project	0	0	0	12
	EC41XX	Program Elective – IV	3	0	0	3						
	EC41XX	Program Elective – V	3	0	0	3						
	EC41XX	Program Elective – VI	3	0	0	3						
	EC41XX	Program Elective – VII	3	0	0	3						
	EC4170	Minor Project - II	0	0	2	1						
	EC4171	Industrial Training	0	0	2	1						
			15	0	4	17			0	0	0	12
	Total Contact Hours (L + T + P)		19				Total Credits=169(including first year)					

THIRD SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications.

MA2103: ENGINEERING MATHEMATICS – III [2 1 0 3]

Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Periodic function, Fourier Series expansion. Even and odd functions, functions with arbitrary periods, Half range expansions Fourier transform, Parseval's identity, PDE-Solution by method of separation of variables and by indicated transformations. One dimensional wave equation, one dimensional heat equation and their solutions. Vector differtial operator, gradient divergence and curl. Line, surface and volume integrals. Green's theorem, Divergence and Stoke's theorem.

References:

1. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
2. Eewin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
3. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, (7e), Pearson Education, 2007
4. R. Spiegel Murray, *Vector Analysis*, 2(e), Schaum Publishing Co., 2009.
5. Ramaniah Narayanan and Manicavachagom Pillay, *Advanced Engineering Mathematics*, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd.1998.

EC2101: SIGNALS & SYSTEMS [3 0 0 3]

Introduction to signals and systems: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties of systems. Time domain representations for Linear time-invariant systems: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems, Differential and difference equation representations for LTI systems, Block diagram representations. Fourier representation for signals: The discrete-time Fourier series, continuous-time periodic signals: The Fourier series, Discrete-time non-periodic signals. Applications of Fourier representations: Introduction, Frequency response of LTI systems, Fourier transform representations for periodic signals, convolution and modulation with mixed signal classes. Applications of Laplace transform: Continuous Time System Analysis using Laplace transform, Region of convergence and Stability, Analysis of continuous time signals and systems. Z-Transform: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Transform analysis of LTI systems, the unilateral Z-Transform.

References:

1. S. Haykin & B. V. Veen, *Signals and Systems*, (2e), John Wiley &Sons, New Delhi, 2007.

2. A.V. Oppenheim, A. S. Willsky & A. Nawab, *Signals and Systems*, (2e), PHI. /Pearson Education, New Delhi, 1997.
3. H. Hsu, R. Ranjan, *Signals and Systems*, (2e), Schaums's outline, Tata McGraw – Hill, New Delhi, 2008.
4. B. P. Lathi, *Linear systems and Signals*, (2e), Oxford University Press, 2005.
5. Tarun Kumar Rawat, *Signals and Systems*, (1e), Oxford University Press, 2010
6. A. Anand Kumar, *Signals and Systems*, (3e), PHI Learning Pvt. Lit., New Delhi, 2015.

EC 2102: ANALOG ELECTRONICS [3 1 0 4]

Junction Diode Analysis: Built in voltage, Transition and diffusion capacitances. Bipolar Junction Transistor: h-parameter model, Hybrid-π model, analysis of CE, CB, and CC configurations of BJT amplifiers, Miller's theorem. Multistage amplifiers: Distortion in amplifiers, Frequency response of an amplifier, bandwidth of cascaded amplifiers, frequency response of an RC coupled, direct coupled and transformer coupled stages. Power amplifiers: Classification of large signal amplifiers, Analysis and design with respect to efficiency, linearity and harmonic distortions of classes of Amplifier. Field Effect Transistor: Structure of JFET and MOSFET, device Characteristics, FET biasing, small signal, Analysis of CS, CD and CG amplifiers at low and high frequencies. Feedback amplifiers: Concept of feedback, types of feedback – their advantages and disadvantages, effect of feedback on frequency response & impedances. Oscillators: Barkhausen criterion for sustained oscillation, Nyquist criterion for stability of amplifier, Types of Oscillators: Hartley and Colpitt's oscillator; Wein bridge oscillator; RC phase shift oscillator; crystal oscillator. Introduction to Power Electronic Devices.

References:

1. J. Millman, C. C. Halkias, *Integrated Electronics,* (2e), Tata McGraw Hill, New Delhi, 2011.
2. B.P. Singh and R. Singh, *Electronic Devices an Integrated Circuits*, (2e), Pearson India, 2012.
3. R. L. Boylestad, L. Nashelsky, *Electronic Devices and Circuit Theory,* (10e), Pearson, 2009.
4. S. Salivahanan, N. S. Kumar, *Electronics Devices and circuits,* (2e), McGraw Hill Publication, 2008.
5. A. S. Sedra, K. C. Smith, *Microelectronic Circuits, Technology and System Applications*, (7e), Oxford University Press, 2014.

EC2103: DIGITAL SYSTEM DESIGN & COMPUTER ARCHITECTURE [3 1 0 4]

Introduction to Combinational logic circuits. Design of arithmetic circuits: code convertors, multiplexers, demultiplexers, encoders, decoders & comparators, Parity generators and checker. Introduction to Sequential Logic: Binary cell, Latches and flip-flops. RS, JK, Master-Slave JK, D & T flip flops. Sequential circuit design: Registers, Shift Registers, Binary Counters, Finite State Machines, Moore and Mealy Machines. Overview of typical computer architecture: Accumulator based, General Register based and Stack based. Data Path and Control Unit Design: Basic concepts, Types of Bus structures, Control Unit design methods-Hardwired and micro programmed. Computer Arithmetic: Fast adders, subtractors, Multiplication of signed and unsigned integers, Booths Multiplication algorithm, Division, Floating Point Arithmetic Operation. Memory Organization: Memory hierarchies- types of ROMs, Main memory- SRAM and DRAM, Memory Address Map; Cache memory- mapping functions – associative, direct and set-associative. Introduction to Verilog programming.

References:

1. S. Brown and Z. Vranesic, *Fundamentals of Digital logic with Verilog Design*, (3e), McGraw Hill, 2014.
2 .M. Mano and M. Ciletti, *Digital Design: With an introduction to Verilog HDL*, (5e), Pearson, 2012.
3 .Z. Navabi, *Verilog Digital System Design,* (2e), McGraw Hill, 2008.
4 .M. Morris Mano, *Computer System Architecture*, (3e), Pearson, 2008.
5. John P. Hayes, *Computer Architecture and Organization*, (3e), TMH, 1998.
6.C. Hamacher, Z. Vranesic, S. Zaky, Computer Organization, (5e), TMH, 2002.

EC2104: ELECTROMAGNETIC FIELD THEORY [3 1 0 4]

Review of Vector Calculus: Cartesian coordinates, Circular, Cylindrical and Spherical co-ordinates. Electrostatics: Coulomb's law and its applications, Electric field intensity and Electrostatic potential due to point charges, Field due to continuous charge distribution. Electric flux and electric flux density, Gauss's law, Gauss's Law – Maxwell's equation, Electric dipole and flux lines, energy density in electrostatic fields., Electric field in material space: convection and conduction currents, conductors, polarization in dielectrics, continuity equation and relaxation time; Electrostatic boundary condition: dielectric-dielectric, dielectric-conductor. Poisson's and Laplace's equations.

Magnetostatics: Magnetic field intensity, Biot-Savart's law, magnetic flux and magnetic flux density, Ampere's law, Maxwell's equation, application of Ampere's law, magnetic flux density- Maxwell's equation, Maxwell's equation for static fields, magnetic scalar and vector potential, magnetic boundary conditions, magnetic energy. Electromagnetic Waves & Applications: Maxwell's equation, Faraday's Law, transformer and motional electromotive forces, displacement current, Maxwell's equation in final form. Maxwell's equations in integral and point form for free space and material media. Electromagnetic wave propagation: Wave propagation in lossy dielectrics, plane waves in lossless dielectrics, plane wave in free space, plane waves in good conductors, power and the pointing vector, reflection of a plain wave in a normal incidence. Introduction to Transmission Lines and waveguides.

References:

1. 1. Jr. Hayt and Bucker, *Engineering Electromagnetics*, (7e), McGraw Hill 2006.
2. 2. M. A. Plonus, *Applied Electromagnetics*, (1e), McGraw Hill 1978.
3. 3. J. D. Kraus, *Electromagnetics,* (4e), McGraw Hill 1992.
4. 4. Cheng, Fields, *Waves and Electromagnetics*, (2e), Addison Wesley, 2004.
5. 5. M. N. O. Sadiku, *Elements of Electromagnetics*, (4e), Oxford University Press, 2006.

EC2130: ANALOG ELECTRONICS LAB [0 0 2 1]

Experiments of this lab are implemented at hardware and software level. Experiments are based on Device characteristics: diodes, BJT and FET, Application of diodes: clippers and clampers, Applications of BJT and FET: amplifiers with and without feedback, RC coupled amplifiers, oscilllators.

EC2131: DSD & HDL LAB [0 0 2 1]

Experiments of this lab are implemented at Hardware as well as software level. List of experiments include: Study of Implementation techniques of combinational circuits, Implementation of Arithmetic circuits using logic gates and MSI chips, Building circuits using MSI chips and their applications, Designing of sequential circuits, Implementation of FSMs, Design of Asynchronous sequential circuits, Design of Combinational & Sequential Circuits using HDL

EC2170: PROJECT BASED LAB - I [0 0 2 1]

Project-based learning is acquiring practical knowledge through experimental setup, this experimentation induces a desire to learn in newly inducted students and influences their minds to understand the applied content. The projects that may be undertaken in Project Based Lab – I include Thermostat for fridge, LED Based Emergency Lamp, Audio controlled running lights, Digital Modern LED Voltmeter, Digital Memory for Door Bell, Hard Disk Reading and writing process, Faraday Cage, Faraday's Guitar, Traffic Light Controller, 4-bit Arithmetic and Logic Unit, etc.

FOURTH SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macro economics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR,AR,MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies,Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e) S. Chand Publication.
2. Peterson H C et.al., *Managerial Economics*, (9e), Pearson, 2012
3. P L Mehta, *Managerial Economics*, Sultan Chand & Sons, New Delhi, 2012.
4. G J Tuesen & H G Tuesen, *Engineering Economics*, PHI, New Delhi, 2008.
5. James L Riggs, David D Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill, 2018.

MA2205: ENGINEERING MATHEMATICS - IV [2 1 0 3]

Finite sample spaces, conditional probability and independence, Baye's theorem, one dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, least squares principles of curve fitting. Binomial, Poisson, uniform, normal, gamma, chi-square and exponential distributions. Moment generating function, functions of one and two dimensional random variables, sampling theory, central limit theorem and applications. Stochastic processes. Difference Calculus, difference equations with constant coefficients, solutions. Finite difference expressions for first and second order derivatives. Solution of boundary value problems, numerical solutions of Laplace and Poisson equations by standard five point formula and heat and wave equations by explicit methods.

References:

1. P.L. Meyer, *Introduction to probability and Statistical applications*, 2(e), American Publishing Co., 1979.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
3. R.V. Hogg and A.T. Craig, *Introduction to Mathematical Statistics* (4e)., MacMillan, 1975
4. S. Narayanan, G. Ramaniah and M Pillay, *Advanced Engineering Mathematics*, Vol 3, S. Viswanathan Printers and Publishers, 1998.

EC2201: ANALOG INTEGRATED CIRCUITS & SYSTEMS [3 0 0 3]

Operational amplifiers: transfer characteristics and frequency response of op-amp, measurement of op-amp parameters. Block level representation of Op-amp; Linear applications of op-amp: voltage to current converter, current to voltage converter, instrumentation amplifier and bridge amplifier. Active filters: Design and analysis of higher order low pass, high pass, band pass (wide and narrow band) and band elimination (wide and narrow band) and all pass active filters. Non-linear applications of operational amplifier: rectifiers, peak detector, sample and hold circuit, comparators, window detector, Schmitt trigger, square wave, triangular wave generators, oscillators. Timer IC: pin details and internal working of 555 IC. Applications: astable multivibrator, monostable multivibrator, Schmitt trigger. Data converters: Principles and specifications of digital to analog converter (DAC) and analog to digital converters (ADC), binary weighted and R-2R DAC, successive approximation type, counter type and servo tracking type and dual slope ADC. Phase-locked loop IC 565 and voltage controlled oscillator IC 566: Analysis and applications. IC based voltage regulators and power amplifiers.

References:

1. R.A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, (4e), Prentice Hall of India, 2002.
2. W. D. Stanley, *Operational Amplifiers with Linear Integrated Circuits*, (4e), Pearson Education, 2007.
3. F. Sergio, *Design with Op amps & Analog Integrated Circuits*, (4e), McGraw Hill, 2014.

EC2202: MICROPROCESSORS & MICROCONTROLLERS [3 1 0 4]

8086 Microprocessor: Introduction and history of microprocessors and microcontrollers, RISC and CISC Architectures. 8086 Architecture: Bus Interface Unit and Execution Unit, Instruction pipeline, Data and Address Bus Configuration, Memory Segmentation, Memory Address generation, I/O Port addressing. 8086 Signals: Functions of all signals, Minimum and Maximum Mode signals, Bus Cycles, Bus Arbitration, Bus driver 8288. 8086 Instruction Set: Types of Instructions and Addressing Modes, assembler and assembler directives, Programming. Basic Peripherals and their interfacing with 8086: Memory interfacing, Types of I/O - Isolated I/O, memory mapped I/O, programmed I/O, Interrupt driven I/O, Interfacing I/O ports, PIO 8255, Programmable Interval Timer 8254, Interrupts, Programmable Interrupt Controller 8259, Keyboard/Display Controller, DMA Controller, DMA transfer and operations, Multiprocessor Systems. 8051 Microcontroller: Architectural features, Programming model, I/O Ports, Special Function Registers, Addressing Modes, Instruction set and Programming.

References:

1. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, *Microprocessors and Microcontrollers,* (1e), Oxford University Press, 2010.
2. K. M . Bhurchandi, A K Ray, *Advanced Microprocessors and Peripheral Devices*, (3e), McGraw Hill Education (India) Private Ltd, 2018.
3. M. A. Mazidi, J. G. Mazidi, R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems using Assembly and C*, (2e), Pearson, 2008.
4. D. V. Hall and S. S. S. P. Rao, *Microprocessors and Interfacing*, (3e), McGraw Hill, 2012.

EC2203: DIGITAL SIGNAL PROCESSING [3 1 0 4]

Review of signals and systems: Time and frequency analysis of signals and systems. Transform Analysis of LTI Systems: The frequency Response of LTI systems, Inverse system, All- Pass system, Minimum Phase system, Linear systems with Generalized Linear Phase. Frequency domain sampling and reconstruction of discrete time signals: Discrete-Time Processing of continuous- Time Signals, Continuous- Time Processing of Discrete-Time Signals, Changing the Sampling Rate Using Discrete-Time Processing. Discrete Fourier transform: Introduction, properties of the DFT, use of DFT in linear filtering, filtering of long data sequences, DFT as linear transformation, Computation of DFT, Decimation-in- Time and Decimation–in–frequency Algorithms. Implementation of discrete time systems: Structures for FIR systems – Direct form, cascade form, Frequency sampling and lattice structures. Structures for IIR systems – Direct form, cascade and parallel form. Design of IIR filters and digital FIR filters: Classical design by impulse invariance, bilinear transformation and matched Z- transform, characteristics and design of commonly used filters – butterworth. Chebyshev, elliptical.

References:

1. A.V. Oppenheim & R.W. Schafer, *Discrete-Time Signal Processing,* (2e), Pearson education, 2001.
2. S. Salivahanan, C. Gnanpriya, *Digital Signal Processing*, (2e), Tata McGraw-Hill Education, 2011.
3. J.G. Proakis, D.G. Manolakis, D. Mimitris*, Introduction to Digital Signal Processing- Principles, Algorithms and Applications*, (3e), Prentice Hall, India 2007.
4. Sanjit K. Mitra, *Digital Signal Processing A Computer Based Approach*, (4e), Mc Graw Hill Education, 2013.
5. L.R. Rabiner & D.J. Gold, *Theory and applications of digital signal processing*, (3e), Prentice Hall, India, 2007.

EC2230: ELECTRONIC SUB-SYSTEM DESIGN LAB [0 0 2 1]

Experiments of this lab are implemented at Hardware as well as software level. Experiments that will be done in this lab include: Measurement of Op-amp parameters: bias current, offset voltage, CMRR, slew rate, Linear and non-linear applications of OP-AMP: inverting amplifier, non-inverting amplifier, voltage follower, adder, averager, scalar, difference amplifier, comparator, integrator, differentiator, active filters, Schmitt trigger, wave generators, oscillators etc, Applications of Timer IC: multivibrator circuits, Schmitt trigger, Applications of IC voltage regulators, etc.

EC2231: DIGITAL SIGNAL PROCESSING LAB [0 0 2 1]

Experiments of this lab are implemented using MATLAB software and Hardware on DSP Processor Kit. The list of experiments includes: Time domain and Frequency Domain Analysis of signals and systems, Analysis in z-domain, Filter Design, Introduction to Code Composer Studio, Filter Implementation using DSP Kits.

EC2232: MICROPROCESSORS & MICROCONTROLLERS LAB [0 0 2 1]

Experiments of this lab are related to 8086 Microprocessor and 8051 Microcontroller based system design along with hardware interfacing in assembly language. Module 1 includes familiarization of 8086 microprocessor simulation tool and trainer kits, experiments based on the Intel 8086 microprocessor like data transfer, arithmetic operations, logical instructions, branch instructions, code conversion, packing and unpacking, sorting, searching, recursion, etc. Module 2 includes familiarization of 8051 microcontroller simulation tool and trainer kits, experiments related to timer, serial data communication, etc based on the Intel 8051 microcontroller assembly language programming/embedded C Programming. Module 3 is related to I/O interfacing of LEDs, LCD, keyboard, 7 segment display, stepper motor, etc. to these microprocessors and microcontrollers.

EC2270: PROJECT BASED LAB - II [0 0 2 1]

Project-based learning is acquiring practical knowledge through experimental setup, this experimentation induces a desire to learn in newly inducted students and influences their minds to understand the applied content. The following projects may be undertaken in Project Based Lab – II: Doorbell cum visitor indicator, Electronic fuse, Geyser timer circuit, Fire sensor, Automatic switch-off battery charger, RF controlled robot, Line Follower, RF based multiple device control, Image enhancement and noise removal using bilateral filter, Image compression using different types of wavelets, Face tracking in real time videos, etc.

FIFTH SEMESTER

BB0026: ORGANIZATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, *Essentials of Management*,(1e) Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

EC3101: ANTENNAS [3 1 0 4]

Introduction: Radiation Mechanism, current distribution, Antenna parameters. Vector potentials: Electric and magnetic vector potentials, solutions for wave equations, far-field radiation, Duality theorem, Reciprocity theorem. Linear wire Antennas: Infinitesimal, small and finite dipole Antennas, Region separation, Half wave length dipole. Loop Antennas: Small circular loop Antenna, circular loop with constant current, Ferrite loop. Antenna Arrays and other types of antennas: Two element array, N-element array – uniform, broadside, ordinary end-fire, Non-uniform Amplitude Arrays, planar and circular arrays. Qualitative study of Folded dipole, long wire, V, Rhombic, Helical, Yagi Uda, log-periodic, Aperture antennas, and horn Antennas, Babinet's principle, Huygens's principle, Rectangular and Circular Microstrip Patch antenna, Quality Factor, Bandwidth, Efficiency. Antenna Measurements: Propagation of EM waves: Ground wave Propagation, Space Wave Propagation, Troposphere and ionosphere propagation and its effect on Radio Waves.

References:

1. C. A. Balanis, *Antenna Theory,* (3e), John Wiley & Sons, New Delhi, 2010.
2. J. Kraus, *Antenna and wave Propagation*, (4e), Tata McGraw – Hill, New Delhi, 2010.
3. K. D. Prasad, *Antenna and Wave Propagation*, (3e), Satya Prakashan, New Delhi, 2009.
4. F. E. Termen, *Radio Engineering*, (1e), Tata McGraw – Hill, New Delhi, 1995.

EC3102: NETWORK & CONTROL THEORY [3 1 0 4]

Network Analysis: Network Theorems. Transients analysis: Impulse, Step, Ramp and sinusoidal response analysis of first order and second order circuits. Two port Networks; Control system: Classification of control systems, Time domain response of 1st and 2nd order systems, Steady state error for linear Systems , RH criteria, Root Locus technique, Bode plots, Nyquist Plots, Frequency domain based compensator design and their realization through OPAMPS, Design/realization of active P, PI, PID controllers for LTI systems. Lead, Lag and Lead-Lag compensators; State space representation: Stability Analysis, State transition matrix, Eigen values, Controllability and observability;

References:

1. Ghosh & Chakraborty, *Network Analysis and Synthesis*, (1e), Tata McGraw Hill Education Private Ltd, 2009.
2. J. B.C.Kuo, *Automatic Control Systems*,(7e), PHI, 2009.
3. Nagrath & Gopal, *Control System Engineering*, (5e), New Age Publications Ltd., 2006.

4. K.Ogata, *Modern Control Engineering*, (2e), Pearson Education, 2010.

EC3103: ANALOG & DIGITAL COMMUNICATION [3 1 0 4]

Introduction to Analog Communication: Amplitude Modulation, Frequency Modulation, Phase Modulation, Representation of Band Pass signals and systems Relationship between PM& FM, Radio Receivers, Superheterodyne Receiver, Noise Theory, Noise Performance of Analog Communication Systems: Introduction to Digital Communication: Line coding, Review of Sampling theorem, uniform and non-uniform quantization, companding, μ-Law and A-Law compressors, Concept and Analysis of PCM, DPCM, DM and ADM modulators and demodulators, M-ary waveforms, S/N ratio for all modulation, probability of error for PCM in AWGN Channel and other modulation techniques, Duo Binary pulse. Digital modulation schemes: Coherent Binary Schemes, Coherent M-ary Schemes, Incoherent Schemes (DPSK and DEPSK), Calculation of average probability of error for different modulation schemes, Power spectra of digitally modulated signals, Performance comparison of different digital modulation schemes.

References:

1. Simon Haykin, *Communication Systems*, (4e), John Wiley, 2009.
2. Taub Schilling, *Principles of Communication Systems*, (3e), McGraw Hill, 2008.
3. G. Kennedy, *Electronic Communication Systems*, (4e), McGraw-Hill, 2008.
4. John G Proakis, M.Salehi and G.Bauch, *Modern Communication System Using MATLAB*, (3e), Cengage Learning, 2013.
5. John G.Proakis, *Digital Communications*, (5e), McGraw Hill, 2008.
6. R.P.Singh & S.D. Sapre, Communication System-Analog and Digital, (2e), McGraw Hill, 2007.

EC3104: CMOS VLSI DESIGN [3 1 0 4]

Introduction: VLSI technology trends, performance measures and Moore's law. MOS devices and circuits: MOS transistors, Study of depletion and enhancement mode operations, Threshold Voltage. Second order effects in MOSFETs. Fabrication of ICs: Lithographic process of MOS and CMOS fabrication, N-well, P-well and twin tub processes, Latch-up in CMOS, SOI process, VLSI Yield and economics. MOS Circuit design & layouts: Implementation of Boolean functions and combinational circuits using switch logic & gate logic, Pass transistors and transmission gates, Pseudo NMOS inverter, Dynamic and clocked CMOS inverters, Clocking strategies. Basic circuit concepts and performance estimation: Sheet resistance, Standard unit of capacitance, Estimation of delay in NMOS and CMOS inverters. Sub system design: Design strategies, Design issues and structured approach, Design examples such as Adders, ALUs and Shifters, Design of sequential circuits. Memory Arrays: SRAM, DRAM. Current trends: BiCMOS devices and circuits.

References:

1. S. M. Kang & Y. Leblebici, *CMOS digital Integrated circuits design and analysis*,(3e), Tata McGraw Hill, 1996.
2. Jan. M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits*,(2e),Pearson, 2003.
3. Neil H. E. Weste & Kamran Eshraghian, *Principles of CMOS VLSI Design*,(2e), Addison Wesley, 1993.

EC3130: VLSI LAB [0 0 2 1]

The objective of this lab is to impart essential practical knowledge on designing of various circuits using CMOS and various other logic families. The learning objective is to make them familiar with industry standard CAD tools. Students will learn to design, analyse and simulate various combinational and sequential circuits in the Digital VLSI circuits using latest EDA tool and analyse them on the basis of noise margin, delay power. The course emphasizes circuit design and analysis skills that require the student to create digital circuits that meet customer/user specifications as industry professional or entrepreneur. Introduction to Layout design.

EC3131: ANALOG & DIGITAL COMMUNICATION LAB [0 0 2 1]

The objective of this lab is to impart essential practical knowledge on analog and digital communication. Hardware Kit/ Matlab/ Labview based practicals on simulation, generation, detection and performance measurement characteristics (S/N and probability of error) of AM, FM, ASK, FSK, PSK, DPSK, QPSK, PCM and DM signal.

EC3170: PROJECT BASED LAB III [0 0 2 1]

Project-based learning is acquiring practical knowledge through experimental setup, this experimentation induces a desire to learn in newly inducted students and influences their minds to understand the applied content. The

following projects may be undertaken in Project Based Lab – III: Designing Planar reflector antenna, Coaxial Antenna Design, Designing FM Dipole Antenna, Multiband CW Transmitter, Cell Phone Jammer Circuit, DTMF Based Remote Control System, VLSI Design of Low-Cost FFT Processors, Design of 16-Bit Multiplier, Low Power 4×4 Bit Multiplier Design, etc.

SIXTH SEMESTER

EC3201: MICROWAVE ENGINEERING [3 0 0 3]

Introduction to Transverse Electric, Transverse Magnetic and Transverse Electromagnetic waves in conducting planes, characteristics of TE, TM and TEM waves, wave impedance, attenuation, TE, TM and TEM waves. Transmission line equations & solutions, reflection and transmission coefficient, standing wave and standing wave ratio, line impedance and admittance, impedance matching, using stub line, application of smith chart in solving transmission line problems. Rectangular and circular waveguides-theory and analysis, characteristics of TE and TM mode and excitation of wave guides. Passive components: Resonators, Directional Couplers, E-plane Tee, H-plane Tee and Hybrid Tee, Hybrid ring, Attenuators, Circulator, Faraday rotation principle, Isolators. Microwave active Devices: Limitations of conventional vacuum tube devices. Two cavity klystron: Re-entrant cavities, velocity modulation process, bunching process. Reflex klystron: Velocity modulation, power output and efficiency and electronic admittance. Traveling wave tube: Slow wave structure, amplification process, convection current, axial electric field, wave modes and gain consideration. Magnetron: Mode of oscillation, Types of Magnetron, Strapping and Rising Sun Magnetron. Microwave diodes and transistors: Tunnel diode, Varactor diode, Gunn diode, IMPATT diode, Microwave transistors and FETs.

References:

1. 1. S. Liao, *Microwave Devices and Circuits*, (3e), Prentice Hall, 1990.
2. 2. D. M. Pozar, *Microwave Engineering*, (4e) John Wiley & Sons, 2012.
3. 3. J. Ryder, *Network lines and Fields*, (2e), Prentice Hall, 2015.
4. Jordan & Balmain, *Electromagnetic waves and Radiating System*, (2e), Prentice Hall, 1968.

EC3202: EMBEDDED & REAL TIME OPERATING SYSTEMS [3 1 0 4]

Embedded Systems: Introduction, Classification, Elements of Embedded Systems, Hardware units, devices, Software, Embedded SOC (System on Chip), Design Process, Process of Embedded system development. Interrupts, Devices and Device Drivers: Interrupts, Interrupt Handling Mechanism, Interrupt Controllers, Interrupt Latency, Timers, Counters, Device Drivers. Buses and Communication Interfaces and protocols. Operating System: Process Management: Processes, Threads, Process Synchronization, Process Scheduling, Deadlock. Inter-process Communication and synchronization of processes, threads and tasks: Semaphores, Synchronization with semaphores and Mutex, Shared data, Signal function, Message function, Mailbox, Pipe. Real Time Operating Systems (RTOS): Introduction, Classification, Services, Process Management, Timer function, Memory Management, Task Scheduling modules, Interrupt latency.

References:

1. Rajkamal, *Embedded Systems: Architecture, Programming and Design*, (2e), McGraw Hill publication, 2008.
2. Frank Vahid, Tony Givargis, *Embedded System Design: A unified Hardware/Software approach*, (3e), John Wiley and Sons, 2009.
3. Abraham Silberschaltz, Peter Baer Galvin, Greg Gagne, *Operating System Concepts*, (9e), John Wiley and Sons, 2013.

EC3203: OPTICAL COMMUNICATION [3 1 0 4]

Introduction to optical communication: Basic principles of light propagation, Propagation of Light in an Optical Fiber: Ray Model, Numerical aperture, phase-front (wavefront) based study of Total Internal Reflection, Wave Model and its Analysis, V number of an Optical fiber. Signal distortion on optical fibers: Material Dispersion, Intermodal Dispersion, Intermodal Dispersion, Material Attenuation, Microbending, Macrobending, Analysis of Signal distortion in optical fibers using OTDR, Practical issues in implementation of fiber link. Optical Sources: Introduction of Optical sources. Light Emitting Diode: Quantum Efficiency, material, electrical and spectral characteristics, modulation. Lasers: Introduction to Laser, Spontaneous emission, Absorption, Stimulated emission, Different type of lasers: ruby

laser, He-Ni laser, semiconductor laser. Optical Receiver: Photon detector, Photo Diodes, Photo detector and its noise Analysis, Optical Receiver, Digital data transmission in optical domain, SNR, BER analysis, Performance Analysis and the EYE-diagram, Receiver Sensitivity Degradation, Fiber Optic link Design, power penalty.

References:

1. G.P Agrawal, *Fiber optics communication*, (3e), John Wiley & sons, 2002.
2. G. Keiser, *Optical Fiber Communication*, (4e), Mc Graw Hill, 2017.
3. M.N. Islam (Ed), *Raman Amplifiers for communications*, (1e), Springer-verlag, New York, 2004.
4. J. M. Senior, *Optical Fiber Communications*, (3e), Prentice Hall of India, 2009
5. J. C. Palais, *Fiber Optic Communications*, (5e), Pearson, 2005.
6. R.W. Waynant & M.N. Ediger, *Electro-Optics Handbook*, (2e), McGraw Hill, 2000.

EC3230: EMBEDDED & RTOS LAB [0 0 2 1]

Experiments of this lab are related to embedded system design using Keil/Arduino software and its implementation on Hardware Kit. Experiments embedded C/Arduino programming for hardware interfacing to various sensors and actuators and implementation of communication protocols like RS 232 communication, SPI, I2C, etc. for embedded systems. Lab also introduces to Linux commands, Shell programming, etc. with introduction to basic concepts of Real Time Operating Systems like Process, Thread, Semaphores, Mutex, IPC, scheduling, etc. Embedded & IoT based system design as a mini project

EC3231: ANTENNA & MICROWAVE LAB [0 0 2 1]

Experiments of this lab are divided into three modules. In modules 1 experiments are related to Microwave Communication which includes: Setting up of a microwave link using klystron and gunn based microwave test bench and verifying the functions of waveguides, E plane Tee, H plane Tee, magic Tee, directional coupler, circulator and isolator. Measurement of resonant frequencies and obtaining VI characteristics of Gunn Diode etc. Module 2 focuses on Transmission Line: Measurement of transmission line parameters, attenuation, phase and fault localization of the line. Experiments in module 3 are related to Antenna Systems: Measurement of the radiation pattern of various types of antennas, half power points, gain, beam width and bandwidth etc. and understand its significance in EM wave propagation.

EC3232: OPTICAL COMMUNICATION LAB [0 0 2 1]

Optical Fiber: Study various types of Optical fibers, optical sources and their radiation patterns, understand use of OTDR for various optical measurements and link analysis, study transmission and reception of analog and digital signals on an optical fiber link, determine the numerical aperture and attenuation constant of fibers. Study of Optical Laser Source, Optical Power Meter, Variable Optical Attenuator, Optical connector certification system, attenuation in optical fiber through, Splice & Connector joints and their losses, Identification of fault location (distance) in the optical fiber, Measurement of fibre losses of single mode fibre due to bending, study the operation of optical fusion splicer, wavelength separation properties of a WDM coupler, study the isolation properties of optical isolators, circulators.

EC3270: MINOR PROJECT – I [0 0 2 1]

To design and present a project related to Electronics and Communication engineering with substantial multidisciplinary component.

SEVENTH SEMESTER

EC4170: MINOR PROJECT – II [0 0 2 1]

To design and present a project related to Electronics and Communication engineering with substantial multidisciplinary component

EC4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a period of 4-6 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training

report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

EIGHT SEMESTER

EC4270: MAJOR PROJECT [0 0 0 12]

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry/ research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be on the basis of the total marks obtained by him/ her out of 400 marks. There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken. The final evaluation and viva voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

PROGRAM ELECTIVES – I & II

EC3244: DATA COMMUNICATION & NETWORK SECURITY [3 0 0 3]

Data communication, communication system, Networking: Needs and Advantages, Network, Types- Client, Server and Peers, introduction to various types of servers, client/server architecture. Transmission Media types: Wired & Wireless transmission. Classification of Networks, Network Topologies. Transmission Modes, Asynchronous & synchronous Transmission, Parallel and Serial Transmission. Connectivity Devices. Real World Networks. IEEE 802 standards. Addressing: physical, port, logical Addresses (IPv4), subnetting, NAT, IPv6. Standards Organizations, OSI reference model TCP/IP suite. TCP/IP protocols: IP, ARP, RARP, ICMP, TCP, UDP TCP/IP Services Protocols: DHCP, DNS, FTP, TFTP, SMTP, TELNET, and NFS. WWW, URL, e-mail, HTTP. Network Security: Network security issues, approaches to network security, hacking. Virus, Worms, Different networking attacks and prevention. Firewalls: types of firewall technology- network level and application level, IP packets filter screening routers, limitations of firewalls. Encryption and Decryption – Cryptography, Public/Private key encryption. Overview of Digital Signature and Digital Certificates Technology Network building blocks required for setting up a small LAN using Windows in an office, Hardware & software required.

References:

1. Fourauzan B., *Data Communications and Networking*, (3e), Tata McGraw-Hill Publications, 2004.
2. Tanenbaum A., *Computer Networks*, (5e), PHI, 2011.
3. Comer D., *Computer Networks and Internet*, (2e), Pearson Education, 1999.
4. S.K.Basandra & S. Jaiswal, *Local Area Networks*, (5e), Galgotia Publications,2009.
5. S. Bose, P. Vijaykumar, *Cryptography and Network Security,* (1e), Pearson Publication, 2016.

EC3245: MIMO WIRELESS COMMUNICATION FUNDAMENTALS [3 0 0 3]

Introduction to wireless communication systems and wireless channels (evolution from 1G-5G, elements of a communication system, layered view of transmitter and receiver). Wireless channel models (Large scale propagation models, Path Loss, Shadowing , Small Scale Propagation Model, Small scale propagation frequency flat fading, Received signal correlation. MIMO channel model Coherence Time, Doppler Shift, Frequency Selective Fading, Coherence Bandwidth, Delay Doppler Characteristics, Spatial Channel Characteristics).Information Theory basics for MIMO communication. Capacity of MIMO Communication systems. (Capacity of deterministic MIMO channels (known and unknown to transmitter), Capacity of Random Channel. Diversity performance of MIMO channels (spatial diversity, Diversity Gain, Transmit Diversity, MIMO Diversity). Space Time Coding schemes, Multi-user MIMO communications.

References:

1. G. Stuber, *Principles of Mobile Communications*, (2e), Springer, 2002.
2. A. Goldsmith, *Wireless Communications*, (2e), Cambridge,2011.
3. A. Paulraj, Nabar and Gore, *Introduction to Space Time Wireless Communications*, (1e), Cambridge University Press, 2003.

4. Bolskei, Gesbert, et al., *Space Time Wireless Communication Systems*, (1e), Cambridge University Press, 2006.
5. Biligeri, et al., *MIMO wireless communications*, (1e), Cambridge University Press, 2010.
6. R. Prasad, Rahman and S. S. Das, *Single and Multi Carrier MIMO Transmission for Broadband Wireless Systems*, (1e), River Publishers Series in Communications, 2009.

EC3246: DIGITAL SYSTEM DESIGN USING FPGAS [3 0 0 3]

Introduction: Digital System implementation using MSI/LSI circuits like PLDs, PLAs and PALs. Full-custom, semi-custom, standard cell based, Programmable ASICs – CPLDs, MPGAs and FPGAs, FPGA Design flow. Sequential Logic Design. Introduction, Basic Bi-stable Memory Devices, additional bi-stable devices, reduced characteristics and excitation table for bi-stable devices. Synchronous Sequential Logic Circuit Design: Introduction, Moore, Mealy and Mixed type, Synchronous State Machines. Synchronous sequential design of Moore, Melay Machines. Algorithmic State Machine. An Algorithm with inputs, digital solution, Implementation of traffic light controller, ASM charts, Design Procedure for ASMs. Digital System Design: Top down and Bottom up approach, Data Path, Control Path, Controller behaviour and Design, Timing of sequential circuits, Pipelining, Resource sharing. FSM issues: State diagram optimization, State Assignment, Asynchronous Inputs, Output Races, Fault Tolerance. Data path and Control design using VHDL/Verilog HDL and it's mapping on FPGA.

References:

1. Zvi Kohavi, *Switching and Finite Automata Theory*, (2e), Tata McGraw-Hill, 2008.
2. Navabi, *Analysis and modeling of digital systems*, (2e) McGraw Hill, 1998.
3. Douglas Perry, *Modeling with VHDL*, (3e), McGraw Hill, 1994.
4. Navabi, *Verilog Digital Design*, (2e), McGraw Hill, 2007.

EC3247: INTERNET OF THINGS [3 0 0 3]

Introduction to IoT: Architecture and Functional blocks of IoT, IoT communication and Technologies, Communication models, supporting protocols & APIs, IoT protocols, IoT levels and Deployment templates. IoT Applications: Home Automation, Health monitoring system, Smart Transportation, Smart City, etc. Machine to Machine: Difference between IoT and M2M, introduction to SDN and NFV for IoT. IoT Platform Design methodology: IoT design process flow, logical design using python. IoT Cloud Platform: Cloud using Web Services, Cloud Computing Services for Sensor Management. Data Analytics: Mongo DB, Map Reduce, Using cloud APIs for analytics, Visualization, NVD3, Mobile interfacing.

References:

1. Vijay Madisetti, Arshdeep Bahga, *Internet of Things: A Hands-On Approach, (1e),* Orient Blackswan Private Limited, 2015.
2. R. Kamal, *Internet of Things – Architecture and Design Principles*, (1e), McGraw Hill, 2017.
3. R. Buyya A. V. Dastjerdi, *Internet of Things: Principles and Paradigms*, (1e), Book ISBN: 9780128093474, Paperback ISBN: 9780128053959, Morgan Kaufmann,2016.

EC3248: ARM SYSTEM DEVELOPMENT [3 0 0 3]

Introduction to microcontroller: Review of History of different types of microprocessors and microcontrollers. ARM Processor Fundamentals: The ARM Design Philosophy, Architecture, ARM Processor Families. Introduction to the ARM Instruction Set: Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions. Introduction to the Thumb Instruction Set: Thumb Register Usage, ARM-Thumb Interworking, Other Branch Instructions, Data Processing Instructions, Single-Register Load-Store Instructions, Multiple-Register Load-Store Instructions, Stack Instructions, Software Interrupt Instruction. ARM Organization and Implementation: 3-stage pipeline ARM organization, 5-stage pipeline ARM organization. Memory Hierarchy: Memory management, On-chip memory, Cache design - an example. Programming with ARM: Programming loops, Character coded data, Code conversion, and Arithmetic examples. Project development.

References:

1. Muhammad Ali Mazidi, *ARM Assembly Language Programming Architecture: Volume (ARM books)*, (2e), MicroDigitalEd.com, 2016.

2. Yifeng Zhu, *Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C*, (2e), E-Man Press LLC, 2015.
3. S. Furber, *ARM System-on- Chip Architecture*, (2e), Pearson Education, 2000.
4. J. R. Gibson, *ARM Assembly Language-an Introduction*, (2e), Dept. of Electrical Engineering and Electronics, The University of Liverpool, 2007.
5. A. N. Sloss, Dominic Symes, Chris Wright, *ARM System Developer's Guide*, (1e), Elsevier, 2004.

EC3249: MEDICAL ELECTRONICS [3 0 0 3]

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio-electrodes and bio-potential amplifiers for ECG, EMG, EEG, etc. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging. Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

References:

1. W.F. Ganong, *Review of Medical Physiology*, (8e), Medical Publishers, 1977.
2. J.G. Websster, ed., *Medical Instrumentation-Application and design*, (4e), Houghton Mifflin, 2010.
3. A.M. Cook and J.G. Webster, eds., *Therapeutic Medical Devices-application and design*, (1e), Englewood Cliffs, N.J., Prentice-Hall, 1982.

EC3250: DEFENCE INFORMATION SYSTEM & ELECTRONIC WARFARE [3 0 0 3]

Electronic Warfare Principles and Overview**:** Electronic Warfare taxonomy, Mission and scenarios, Components of EW and SIGINT, Electronic Support Measures (ESM) fundamentals, Operational use of EW in air, land and maritime domains. Intelligence Surveillance Target Acquisition and Reconnaissance (ISTAR), Force protection. Anti-Submarine Warfare Fundamentals: Interpreting and exploiting the underwater environment, Pre-mission threat assessments and awareness of evolving technologies, Prediction of target detection ranges and sensor deployment. Detection and tracking using SONAR and non-acoustic methods. Air and Maritime Platform Protection**:** Threat systems, Platform vulnerability, Stealth technology overview, Threat avoidance and detection, Countering the threat through jamming, Introduction to Suppression of Enemy Air Defence (SEAD), Radio Controlled Improvised Explosive Device (RCIED), Introduction to EW planning, Electronic Orders of Battle (EOB) production.

References:

1. Curtis Schleher. D., *Introduction to Electronic Warfare*, (1e), Artech House Inc.1986.
2. Sergei A. Vakin, Lev N. Shustov, Robert H. Dunwell, *Fundamentals of Electronic Warfare*, (1e), Artech House Inc., 2001.
3. Richard Poisel, *Introduction to Communication Electronic Warfare Systems*, (2e), Artech House Inc., 2008.

PROGRAM ELECTIVES –III, IV, V, VI & VII

EC3240: WIRELESS COMMUNICATION & NETWORKS [3 0 0 3]

Introduction to wireless channels and wireless networks, wireless channel as a random linear time varying system, Wireless channel modeling, Advantages and disadvantages of Wireless Networks, WLAN Topologies, WLAN Standard IEEE 802.11 and IEEE 802.11 a, b, g and n standards. Outdoor Propagation Models- Longley Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model, Wideband PCS Microcell Model, Indoor Propagation Models-Partition losses (Same Floor), Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model. Fading and diversity techniques, Diversity improvement, Maximal Ratio Combining, Practical Space Diversity, Selection Diversity, Scanning Diversity, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver. Wireless channel capacity, ergodic capacity and outage capacity. Introduction to MIMO systems

References:

1. Upena Dalal, *Wireless Communication, (1e),* Oxford University Press, 2009.
2. T. S. Rappaport, *Wireless Communication: Principles and Practice, (2e),* Pearson, 2010.
3. Andreas.F. Molisch, *Wireless Communications, (2e),* John Wiley – India, 2013.
4. William Stallings, *Wireless Communications & Networks,* (2e), Pearson, 2005.

EC3241: RADAR & SATELLITE COMMUNICATION [3 0 0 3]

Introduction to Radar: Introduction, block diagram, applications, radar frequencies, different types of radar, basic pulsed radar system, radar equation, system losses. Radar Antennas: Introduction, parameters of radar antennas, different types of radar antennas, Radomes. Radar Transmitter: Introduction, radar RF source. Radar Receiver: Introduction, radar receiver noise, and Duplexers: Introduction types, used in modern radar, Radar Display Units: Introduction, types of scope. Navigation: Introduction, history, methods of navigation. Satellite Communications: The Origin of satellite communications, brief history of satellite communications, advantages and disadvantages, current status of satellite communication, active and passive satellites. Satellite Subsystems: Introduction, satellite subsystems, altitude and orbit control system, telemetry, tracking and command, communication subsystem, communication subsystem components. Earth Station Technology: Introduction, earth station design requirements, earth station antenna design, earth station sub-system, tracking monitoring and control. Satellite Applications: Introduction, satellite for earth observation, satellite for weather forecast, satellite for scientific studies, and satellite for military applications, direct broadcast satellite system, very small aperture terminal, global positioning system.

References:

1. M. I. Skolnik, Introduction to Radar Systems, (3e), McGraw Hill, 2003.
2. T. Pratt, C. W. Bostian, J. E. Allnutt, Satellite communication system, (2e), John Wiley and Sons (2002).
3. P. Z. Peebles Jr., Radar Principles, (1e), John Wiley, 1998.
4. E. Byron, Radar: Principles, Technology, Applications, (1e), Prentice- Hall education, 1992.
5. D. Barton, Radar system analyses and Modeling, (2e), Artech house, 2005.
6. M. Antonio, Bistatic radar emerging technology, (1e), John Wiley, 2008.
7. D. Roddy, Satellite communications, (4e), McGraw-Hill international edition, 2017.

EC3242: VLSI TESTING & TESTABILITY [3 0 0 3]

Physical Faults and their modeling: Stuck at Faults, Bridging Faults; Fault collapsing; Fault Simulation: Deductive, Parallel and Concurrent Fault Simulation. Critical Path Tracing. ATPG for Combinational Circuits: D-Algorithm, Random, Deterministic and Weighted Random Test Pattern Generation; Aliasing and its effect on Fault Coverage.; Controllability and Observability Scan Design, Boundary Scan for Board Level Testing; Memory Testing: Permanent, Intermittent and Pattern Sensitive Faults, Marching Tests;. PLA Testing: Cross Point Fault Model and Test Generation. Compression Techniques: General Aspects of Compression Techniques; Ones-Count, Transition Count and Parity Check Compression; Syndrome Testing; Signature Analysis; Built-In-Self-Test (BIST) Concept: Test-Pattern generation for BIST; Specific BIST Architecture; Introduction to Built-In-Self-Repair (BISR) Approaches.

References:

1. M. Abramovici, M. A. Breuer, & A.D. Friedman, *Digital Systems Testing and Testable Design, (1e),* Piscataway, New Jersey: IEEE Press, 1994.
2. M. L. Bushnell and V. D. Agrawal, *Essentials of testing for digital, memory and mixed-signal VLSI circuits*, *(1e),* Boston: Kluwer Academic Publishers, 2000.

EC3243: VLSI/ULSI PROCESS TECHNOLOGY [3 0 0 3]

Introduction of semiconductor and process technology, Materials for VLSI/ULSI process technology. Crystal growth & Silicon Oxidation: Silicon Crystal Growth - Czochralski and Float Zone Technique, Distribution of dopants, Segregation/Distribution coefficient. Material properties: Physical properties, Crystal structure, Packing Density, Defects, Dislocation; Silicon oxidation: Thermal Oxidation process- Kinetics of oxide Growth. Photolithography: Photo resists, Lift Off technique, Optical Lithography, masks, photo resists, Pattern transfer, Resolution enhancement techniques, Next generation lithography- electron beam lithography. Diffusion & Ion implantation: Basic diffusion process, Fick's law, Pre-deposition and drive-in diffusion, Diffusion profile for various dopants, Lateral Diffusion, Range of Implanted Ions, straggle, ion stopping, ion Channeling, Annealing, Rapid Thermal Annealing. Etching: Wet chemical etching of Silicon, Silicon dioxide, Silicon Nitride and Aluminum. Dry etching, Plasma fundamentals and etch mechanism. Epitaxy: Epitaxial growth technique, Molecular beam epitaxy; Metallization: evaporation and sputtering, realizing resistor; single and double damascene process. Overview of MOS and CMOS process technology, Fundamental considerations for optimizing the process technology with latest technology nodes.

References:

1. S. M. Sze, *VLSI Technology*, (2e), McGraw Hill, 1988.
2. S.K. Gandhi, *VLSI Fabrication Principles*, (2e), John Wiley & Sons, 1983.
3. S. A. Campbell, *The Science & Engineering of Microelectronic Fabrication*, (2e), Oxford University Press, 2005.
4. G.S. May & S. M. Sze, *Fundamentals of Semiconductor Fabrication*, (1e), Wiley, 2004.

EC4140: MOBILE COMMUNICATION & NETWORKS [3 0 0 3]

Evolution and Fundamentals, Examples of Wireless Communication Systems, Cellular network systems, Trends in Cellular Radio and Personal Communication Systems; Cellular Concepts: Frequency for Radio Transmission, Frequency Reuse, Channel Assignment Strategies. Handoff Strategies, Interference and System Capacity, Cell Splitting, Sectoring. Medium Access Control, Hidden, Exposed and Capture nodes, Far and Near Problem, Protocol for MAC; Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Ground Reflection Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models. Multipath Measurements, Parameters of Multipath Measurements. Modulation Techniques used for Mobile Radio, System Architecture, Radio Subsystem Wireless Systems and Standards; Channel Types, Frame Structure, Signal Processing in GSM and CDMA; Digital Cellular Standards, Emerging technologies including 4G and 5G, and infrastructure less networks, Future advancement in Mobile Network.

References:

1. T. S. Rappaport, *Wireless Communications Principles and Practice*, (2e), Pearson Education, Asia, 2002.
2. K. Feher, *Wireless Digital Communications, Modulation and Spread Spectrum Applications*, (1e), Eastern Economy Edition, 1995.
3. W. C. Y. Lee, *Mobile Cellular Telecommunications*, (2e), McGraw Hill International, NY, 1995.
4. J. H. Schiller, *Mobile Communication, (2e),* Harlow: Addison-Wesley, 2003.

EC4141: MODERN ANTENNA TECHNOLOGY [3 0 0 3]

Antenna Terminology: Basic antenna parameters, patterns, isotropic antenna, Gain, Directivity, lobes, polarizations, Field regions. Reflector antenna- Introduction, plane Reflector, corner, parabolic, spherical reflector. Microstrip antennas: Microstrip radiators, various microstrip antenna configurations, Analytical models for microstrip antennas, Transmission line model, Cavity Model, Full wave analysis of microstrip antennas. Modern antennas: Frequency Independent antenna, Reconfigurable antenna, Active antenna, Dielectric antennas, Electronic band gap structure and applications. Smart Antennas –Introduction, smart antenna analogy, smart antenna benefits & drawbacks, antenna beamforming. Antenna Measurements: Introduction, Antenna ranges, Radiation pattern, Return loss, Gain /Directivity measurements, Polarization measurements.

References:

1. C. A. Balanis, *Antenna Theory*, (3e), John Wiley & Sons, Inc, U.K. 2005.
2. J. D. Kraus, *Antennas*, (1e), McGraw-Hill, New York, 1988.
3. R. E Collin, *The Receiving Antennas*, (1e), McGraw-Hill, 1969.
4. C. Fernandes, R. K. Jha, C. Salema, *Solid Dielectric Horn Antennas*, (1e), Artech House, 1998.
5. S. Drabowitch, *Modern Antennas,* (2e), Springer Publications, 2007.

EC4142: ANALOG VLSI DESIGN [3 0 0 3]

Review of MOS Transistor operation models and equivalent circuits for low and high frequency. Single-Stage Amplifiers: CS, CG, CD, Cascode amplifiers, Differential Amplifiers: Common mode, differential mode response analysis and gain calculation. Passive and Active Current Mirrors: Cascode current mirror, current mirror as an active device, Miller effect for frequency response of amplifiers, Feedback amplifiers, Theory and design of MOS Operational Amplifier, Stability and Frequency compensation of operational amplifiers. Comparators and Voltage Reference Sources. Switched Capacitor Circuits: Principles of operation of Switched Capacitor Circuits, Switched Capacitor Filters.

References:

1. Behzad, Razavi, *Design of Analog CMOS Integrated Circuits*, (2e), McGraw Hill, 2001.
2. Allen Holberg, *CMOS Analog Integrated Circuit Design*, (3e), Oxford University Press, 2012.
3. P. R.Gray, Hurst, Lewis and R. G. Meyer, *Analysis and Design of Analog Integrated Circuits*, (4e), John Wiley, 2001.

EC4143: VLSI CAD [3 0 0 3]

Introduction to CAD tools: Evolution of Design Automation, Basic Transistor Fundamentals, CMOS realizations of basic gates, Modeling techniques, Types of CAD tools and Introduction to logic simulation. Simulation and Logic Synthesis: Simulation, Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams, Two Level Logic Synthesis. Logic synthesis: two-level and multilevel gate-level optimization tools, state assignment of finite state machines, Estimating delays in a circuit, issues in Dynamic and Static Timing Analysis. Basic concepts of high-level synthesis: partitioning, scheduling, allocation and binding, Memory modeling Synthesizable and non- synthesizable constructs, Logic Optimization, Optimizing logic using resource sharing, Introduction to Logical Effort, Multistage Logic Networks, Logical Effort and Gain Based Synthesis, Logical Effort Optimizing performance.

References:

1. Samir Palnitkar, *Verilog HDL*, (2e), Pearson, 2004.
2. S.Imam, M. Pedram, *Logic Synthesis for Low Power VLSI Designs*, (1e), Kluwer, 1997.
3. M.Smith, Application *Specific ICs*, (1e), Pearson, 1997.
4. S.Palnitkar, Verilog HDL, *A Guide to Digital Design and Synthesis*, (2e), Prentice Hall PTR, 2003.
5. S.Brown S., Z.Vranesic, *Fundamentals of Digital Logic with Verilog Design*, (2e), TMH, 2007.
6. Rabaey, J. M., Chandrakasan, A. P., & Nikolic, B., *Digital integrated circuits* (2e), Englewood Cliffs, Prentice hall, 2002.

EC4144: WIRELESS & ADHOC NETWORKS [3 0 0 3]

Introduction and Issues in Ad-Hoc Wireless Networks. MAC Protocols, Issues, Classifications of MAC protocols, Multi-channel MAC & Power control MAC protocol. Issues – Classifications of routing protocols – Hierarchical and Power aware. Multicast routing –Classifications, Tree based, Mesh based. Ad Hoc Transport Layer Issues. TCP Over Ad Hoc –Feedback based, TCP with explicit link, TCP-BuS, Ad Hoc TCP, and Split TCP. Introduction – Sensor Network Architecture, Data dissemination, Gathering. MAC Protocols, self-organizing, Hybrid TDMA/FDMA and CSMA based MAC, WSN routing, OLSR, AODV. Localization Indoor and Sensor Network Localization. QoS in WSN, Self-configuration and Auto configuration, Capacity Models, Fairness, Heterogeneous Mesh Networks, Vehicular Mesh Networks.

References:

1. C. Siva Ram Murthy and B. S Manoj, *Ad Hoc Wireless Networks – Architectures and Protocols*, (1e), Pearson Education, 2004.
2. Feng Zhao and Leonidas Guibas, *Wireless Sensor Networks,* (1e), Morgan Kaufman Publishers, 2004.
3. C. K. Toh, *Ad Hoc Mobile Wireless Networks,* (1e), Pearson Education, 2002.

EC4145: ADAPTIVE SIGNAL PROCESSING [3 0 0 3]

Complex-Valued Adaptive Signal Processing: Optimization in the Complex Domain, Widely Linear Adaptive Filtering, Nonlinear Adaptive Filtering with Multilayer Perceptrons, Complex Independent Component Analysis. Robust Estimation Techniques for Complex-Valued Random Vectors: Statistical Characterization of Complex Random Vectors, Complex Elliptically Symmetric (CES) Distributions, Tools to Compare Estimators, Scatter and PseudoScatter Matrices Array Processing Examples, MVDR Beamformers Based on M-Estimators, Turbo Equalization: Communication Chain. Turbo Decoder: Overview, Forward-Backward Algorithm, Simplified Algorithm: Interference Canceler, Capacity Analysis, Blind Turbo Equalization, Convergence, Multichannel and Multiuser Settings. Subspace Tracking for Signal Processing: Linear Algebra Review, Observation Model and Problem Statement, Preliminary Example: Oja's Neuron, Subspace Tracking, Eigenvectors Tracking, Convergence and Performance Analysis Issues. Particle Filtering: The Basic Idea, The Choice of Proposal Distribution and Resampling, Some Particle Filtering Methods, Handling Constant Parameters, Rao–Blackwellization, Prediction, Smoothing.

References:

1. Tulay Adalı, Simon Haykin, *Adaptive Signal Processing-Next Generation Solutions*, (1e), John Wiley & Sons, 2010.
2. Dimitris G. Manolakis, Dimitris Manolakis, Vinay K. Ingle, Stephen M. Kogon, *Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing*, (1e), Artech House, 2005.

3. Ali H. Sayed, *Fundamentals of Adaptive Filtering*, (1e), John Wiley, 2003.

EC4146: INFORMATION THEORY & CODING [3 0 0 3]

Random Signal Theory: Introduction to random variables and random processes, probability distribution- Binomial, Poisson and Normal distributions, Cumulative Distribution Function, Joint Distribution, Independent random variable and conditional distribution, Characteristics of random variable-Mean, variance and standard deviation. Information Theory: Introduction to information theory and probability, entropy, rate of information, Joint and conditional entropy. Mutual information: noise free channel, channel with independent input and output. Channel capacity: Binary symmetric channel, binary erasure channel, noise free channel, cascaded channels, and binary channel. Coding: Introduction, code efficiency, Shannon theorem, capacity of Gaussian channel, Bandwidth and S/N trade off Shannon-Fano coding, Huffman coding, LZ coding, Error control coding, Automatic Repeat Request and Forward error correction codes, Block codes and parity check codes, Hamming Weight, Hamming Distance, Minimum distance decoding, Single Parity codes, Repetition Codes, Hamming Codes, Linear block codes, Cyclic code, Convolution code, Turbo Codes.

References:

1. M. Kulkarni & K. S. Shivaprakasha, *Information Theory and Coding,* (1e), Wiley India Pvt. Ltd, First edition,2014.
2. A. Saha, N. Manna and S. Mandal*, Information Theory and Coding*, (1e), Pearson Education, First edition,2013.
3. P.Z. Peebles, *Probability, Random Variables and Random Signal Principles*, (4e), Mc-Graw Hill, 2000.
4. F.M. Reza, *Information Theory,* (1e), Tata McGraw Hill, 1961.
5. R D Singh and S D Sapre, *Communication Systems*, (2e), Tata McGraw Hill, 1995.
6. R. Bose, *Information Theory, Coding and Cryptography,* (2e), Tata McGraw Hill, 2001.

EC4147: PHOTONICS & OPTOELECTRONICS [3 0 0 3]

Nature of light, light sources, black body, colour temperature, units of light, radio metric and photometric units, basic semiconductors, PN junction, carrier recombination and diffusion, injection efficiency, heterojunction, internal quantum efficiency, External quantum efficiency, double hetero junction, fabrication of heterojunction, quantum wells and super lattices. Opto-electronic devices, Optical modulators, modulation methods and modulators, transmitters, optical transmitter circuits, LED and laser drive circuits, LED-Power and efficiency, double hereostructure LED, LED structures, LED characteristics, laser modes, strip geometry, gain guided lasers, index guided lasers. Modulation of light, birefringence, electrooptic effect, EO materials, Kerr modulators, scanning and switching, self electro optic devices, MO devices, AO devices, AO modulators. Display devices, Photoluminescence, cathodo luminescence, EL display, LED display, drive circuitry, plasma panel display, liquid crystals, properties, LCD displays, numeric displays. Photo detectors, thermal detectors, photoconductors, detectors, photon devices, PMT, photodiodes, photo transistors, noise characteristics of photo-detectors, PIN diode, APD characteristics, APD Design of detector arrays, CCD, Solar cells.

References:

1. J Wilson and J F B J iS Hawkers, *Opto electronics - An introduction*, (2e), Prentice-Hall India, 1993.
2. J M Senior, *Optical fibre communication*, (3e), Prentice Hall India, 1992.
3. J Gowar, *Optical fibre communication systems*, (3e),Prentice Hall, 1993.
4. J. C. Palais, *Introduction to optical electronics*, (5e), Prentice Hall, 2004.
5. Jasprit Singh, *Semiconductor opto electronics*, (1e), McGraw-Hill, Inc, 1995.
6. P Bhattacharya, *Semiconductor optoelectronic devices*, (2e), Pearson, 1996.
7. R. P. Khare, *Fibre Optics and Opto-electronics*, (1e), Oxford University Press, 2004.

EC4148: NANOPHOTONICS [3 0 0 3]

Foundations for Nanophotonics: Confinement of Photons and Electrons, Propagation Through a Classically Forbidden Zone, Localization Under a' Periodic Potential, Axial and Lateral Nanoscopic Localization, Nanoscale Confinement of Electronic Interactions, Quantum Confinement Effects, Near-Field Interaction and Microscopy, Modeling of Near-Field Nanoscopic Interactions, Near-Field Microscopy, Quantum-Confined Materials, Manifestations of Quantum Confinement, Optical Properties, Quantum-Confined Stark Effect, Dielectric Confinement Effect, Growth and Characterization of Nanomaterials: Growth Methods for Nanomaterials,

Nanochemistry, Nanostructured Molecular Architectures, Photonic Crystals, Theoretical Modeling of Photonic Crystals, Methods of Fabrication, Photonic Crystal Fibers (PCF), Photonic Crystals and Optical Communications, Photonic Crystal Sensors. Nanocomposites, Nanocomposite Waveguides, Multiphasic Nanocomposites, Nanocomposites for Optoelectronics, Industrial nanophotonics: Nanolithography, , Nanoparticle Coatings, Sunscreen Nanoparticles, Self-Cleaning Glass Fluorescent Quantum Dots, Nanobarcodes, Bio Nanophotonics and nanomedicine, Nanoparticles for Optical Diagnostics and Targeted Therapy, Semiconductor Quantum Dots for Bioimaging Biosensing, Nanoclinics for Optical Diagnostics and Targeted Therapy, Nanoclinic Gene Delivery Nanoclinics for Photodynamic Therapy.

References:

1. P N Prasad, *Nanophotonics,* (1e), Wiley Interscience, 2003.
2. P N Prasad, *Introduction to Biophotonics,* (1e), Wiley Publications, 2004.

EC4149: FREE SPACE OPTICAL COMMUNICATION [3 0 0 3]

Overview of Wireless Optical Communication Systems, Outdoor/Free-Space Optical Communication, Comparison of FSO and Radio-Frequency Communication Systems, Choice of Wavelength in FSO Communication System, Range Equation for FSO Link, Technologies Used in FSO, Applications of FSO Communication Systems, Free-Space Optical Channel Models, Atmospheric Channel, Atmospheric Losses, Absorption and Scattering Losses, Free-Space Loss, Beam Divergence Loss, Loss due to Weather Conditions, Pointing Loss, Atmospheric Turbulence, Atmospheric Turbulent Channel Model, Techniques for Turbulence Mitigation. Optical Transmitter, Choice of Laser, Modulators, Modulation Schemes, Optical Receiver, Types of Detectors, Receiver Configuration, Link Design Trade-Off. Acquisition, Tracking, and Pointing, Scanning Techniques, Acquisition Approach, Beam Divergence and Power Criteria for Acquisition, Tracking and Pointing Requirements, Integration of Complete ATP System, ATP Link Budget. BER Performance of FSO System, Link Performance Improvement Techniques, Aperture Averaging, Aperture Averaging Factor, Aperture Averaging Experiment, Diversity, Types of Diversity Techniques, Diversity Combining Techniques, Coding, Channel Capacity, Channel Coding in FSO System. Link Feasibility Study, Link Requirements and Basic Parameters, Transmitter Parameters, Atmospheric Transmission Loss Parameter, Receiver Parameters, Link Power Budget.

References:

1. H. Kaushal, V.K. Jain, S. Kar, *Free Space Optical Communication*, (1e), Springer, 2017.
2. B. Djordjevic, *Advanced Optical and Wireless Communications Systems*, (1e), Springer, 2018.
3. O. Bouchet, H. Sizun, C. Boisrobert, F. de Fornel and P. Favennec, *Free-Space Optics: Propagation and Communication* , (1e), Wiley, 2006.
4. N. Ismail, *Free Space Optics (FSO): Design and Analysis of a 50km Free Space Optical Communication Link (FSO) operating at 2.5Gbps* , (1e), LAP LAMBERT Academic Publishing, 2011.
5. Arun K. Majumdar, *Advanced Free Space Optics (FSO),* (1e), Springer, 2015.

EC4150: OPTICAL NETWORKS [3 0 0 3]

Optical system components: Light propagation in optical fibers – Loss & bandwidth, System limitations, Non-Linear effects; Solitons; Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters. Optical Networking: Introduction: circuit switching and packet switching, optical layer, network evolution. Optical networking components/building blocks: Optical fibers, Optical transmitter, receiver and filters, multiplexers, switching elements, wavelength converter, and optical amplifiers. Client layers of the optical layer, WDM network elements. Optical switching: Packet switching, burst switching, MEMs based switching, switching with SOAs. Optical Metro Network: SONET/SDH, Fault management in SONET/SDH. Optical Access Network: Access networks, Photonic packet switching. Deployment considerations. Overview of PON technologies, Ethernet access network, WDM-PON. Control and management, network survivability, protection schemes.

References:

1. C. Sivaramamurthy & M. Gurusamy, *WDM Optical Networks: Concepts, Design, and Algorithms*, (1e), Prentice Hall, 2002.
2. Rajiv Ramaswami and Kumar N. Sivarajan, *Optical Networks : A Practical Perspective*, (2e), Harcourt Asia Pte Ltd., 2004..
3. John M. senior, *Optical fiber communication : Principles and Practice* , (3e), Pearson, 2009.

4. G.E. Keiser, *Optical fiber communication*, (5e), McGraw Hill, 2017.
5. P.E. Green, Jr., *Fiber Optic Networks*,(1e), Prentice Hall, NJ, 1993.
6. Biswanath Mukherjee, *Optical WDM Networks*, (1e), Springer, 2006.

EC4151: POWER ELECTRONICS [3 0 0 3]

Power Semiconductor devices: SCR, GTO, BJT, Power MOSFET, IGBT – characteristics, safe operating area, device rating, base/gate drive requirements, Converter Topologies: Controlled Rectifiers, Single phase converters, Three-phase Converters- half controlled & fully controlled bridge, Line commutated inverters, Dual converters, AC to AC converters: Cycloconverters and AC voltage regulators, DC – DC Converters: Buck, Boost, Cuk, SEPIC, Isolated Converters DC – AC Converters: Single phase and three phase bridge inverters, Square wave operation, PWM Inverters- PWM techniques, harmonics in output voltage , Multi-level inverters, Space vector modulation, Resonant converters: Principle of soft switching- concept of zero current switching and zero voltage switching.

References:

1. D. W. Hart, *Introduction to Power electronics,* (1e), Prentice Hall, 1996.
2. M. H. Rashid, *Power Electronics Circuits, Devices and Applications*, (3e), Prentice-Hall of India, Private limited, New-Delhi, 2004.
3. N. Mohan, *Power Electronics – Converters, Applications and Design,* (3e), John Wiley & Sons. INC, 2002.
4. L. Umanand, *Power Electronics – Essentials and Applications*, Wiley India Pvt. Ltd., 2014.

EC4152: LOW POWER VLSI DESIGN [3 0 0 3]

Need for Low Power design, Sources of power dissipation in Digital Integrated circuits. Emerging low power approaches, Hierarchical Low Power Design Methodologies. Physics of power dissipation in CMOS devices, Dynamic and static power dissipation, Transistor sizing & gate oxide thickness. Impact of technology Scaling and Device innovation. Random logic signals, probability and frequency, probabilistic power analysis techniques, signal entropy, Power consumption in circuits. Design of Flip Flops and Latches. Low Power Dynamic logic families and Adiabatic Logic Families. Gate reorganization, pre-computation logic, signal gating, logic encoding, state machine encoding, reduction of power in address and data buses; Power dissipation in clock distribution, Zero skew versus Tolerable skew, Power and performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

References:

1. G. K. Yeap, *Practical Low Power Digital VLSI Design,* (1e), Kluwer Academic, 2002.
2. Rabaey, Pedram*, Low power design methodologies*, (1e), Kluwer Academic, 1997.
3. K. Roy, S. Prasad, *Low Power CMOS VLSI Circuit Design*, (1e), Wiley, 2000.
4. Kiat, Samir S, R. S. Yeo, W. L. Goh, *CMOS/BiCMOS ULSI Low Voltage Low Power*, (1e),
5. Pearson, 2002.

EC4153: CAD ALGORITHMS FOR SYNTHESIS OF DIGITAL SYSTEMS [3 0 0 3]

Role of CAD in digital system design, levels of design, modeling & description and support of languages, RTL, gate and system level synthesis; Technological alternatives and technology mapping; CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.

References:

1. G. D. Micheli, *Synthesis and optimization of digital systems*, (1e), Mc Graw Hill, 1994.
2. Dutt, N. D. and Gajski, D. D. *High level synthesis- Introduction to Chip and System Design*, (1e), Kluwer, 1992.
3. T. H. Cormen, C. E. Leiserson and R. L. Rivest, *Introduction to Algorithms*, (2e), McGraw-Hill, 2001.
4. N. Deo, *Graph Theory with Applications to Engineering and Computer Science*, (1e), PH India, 2004.

EC4154: MEMS DEVICES AND TECHNOLOGY [3 0 0 3]

Overview of MEMS and Microsystems: Introduction Microsystem vs. Microelectronics, the Multidisciplinary Nature of Microsystem design and manufacture, Application of MEMS in various industries. MEMS and Miniaturization: Materials for MEMS and Microsystems – Si as substrate material, mechanical properties of Silicon, Silicon Compounds (SiO2, Si3N4, SiC, PolySi, Silicon), Piezoresistors, Piezoelectric crystals, Packaging Materials.

Micromachining Processes: Overview of microelectronic fabrication processes used in MEMS, Bulk Micromachining – Isotropic & Anisotropic Etching, Comparison of Wet vs Dry etching, Surface Micromachining – General description, Processing in general, Mechanical Problems associated with Surface Micromachining, Introduction to LIGA process, Introduction to Bonding. Assembly of 3D MEMS - foundary process. Microsystems & MEMS Design: Design Considerations: Design constraints, Selection of Materials, Selection of Manufacturing processes, Selection of Signal Transduction, Electromechanical system, packaging. Process design, Mechanical Design – Thermo mechanical loading, Thermo mechanical Stress Analysis, Dynamic Analysis, Interfacial fracture Analysis, Mechanical Design using Finite Element Method. Case study of MEMS Presure senor: Design and fabrication considerations.

References:

1. S. M. Sze*, VLSI Technology,* (2e), McGraw Hill, 1988.
2. S.K. Gandhi, *VLSI Fabrication Principles*, (2e), John Wiley & Sons, 1983.
3. S. A. Campbell, *The Science & Engineering of Microelectronic Fabrication*,(2e), Oxford University Press, 2005.
4. G.S. May & S. M. Sze, *Fundamentals of Semiconductor Fabrication*, Wiley, 2004.
5. Microsystem Design By Stephen D. Senturia, Kluwer Academic Publishers (2003)
6. Micro Technology and MEMS By M. Elwenspoek and R. Wiegerink, Springer (2000)

EC4155: FUNDAMENTAL OF ROBOTICS SYSTEM [3 0 0 3]

Introduction and Mathematical Representation of Robots: Brief History of Robotics, Types of Robots, Technology of Robots, Basic Principles in Robotics. Position and Orientation of a Rigid Body, Transformation Between Coordinate Systems, Representation of Joints, Representation of Links Using Denavit–Hartenberg Parameters, Link Transformation Matrices, examples. Kinematics of Serial Manipulators: Direct Kinematics of Serial Manipulators, Inverse Kinematics of Serial Manipulators, examples. Kinematics of Parallel Manipulators: Direct Kinematics of Parallel Manipulators, Inverse Kinematics of Parallel Manipulators, examples. Velocity Analysis and Statics of Manipulators: Linear and Angular Velocities of Links in Serial Manipulators, Serial Manipulator Jacobian, Parallel manipulator Jacobians, Singularities of Serial and Parallel Manipulators, Statics of Serial Manipulators, Statics of Parallel Manipulators, examples. Dynamics of Manipulators: Dynamic Equations in Cartesian Space, Inverse Dynamics of Manipulators, Recursive Formulations of Dynamics of Manipulators, Newton–Euler Formulation for Inverse Dynamics, Algorithms for Forward Dynamics, examples.

References:

1. Ashitava Ghosal, *Robotics Fundamental Concepts and Analysis*, (1e), illustrated, OUP India, 2006.
2. R K Mittal and I. J. Nagrath, *Robotics and Control*, (1e), Tata McGraw-Hill Education, 2003.
3. H. Asada and J. J. Slotine, *Robot Analysis and Control*, (1e), New York, NY: Wiley, 1986.
4. M. Spong, M. Vidyasagar, S. Hutchinson, *Robot Modeling and Control*, (1e), Wiley & Sons, 1989.
5. John J. Craig, *Introduction to Robotics: Mechanics and Control*, (3e), Addison-Wesley Publishing Company, 2003.

EC4156: MACHINE LEARNING & AI [3 0 0 3]

Introduction: Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Applications of Artificial Intelligence, Intelligent Agents, Structure of Intelligent Agents. Computer vision, Natural Language Possessing. Introduction to Search : Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning. Knowledge Representation & Reasoning: Propositional logic, Theory of first order logic Inference in First order logic, Forward & Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks. Machine Learning : Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data - Naive Bayes models, Learning with hidden data - EM algorithm, Reinforcement learning. Pattern Recognition : Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parameter estimation methods - Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques – Nearest Neighbor (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K – means clustering.

References:

1. Stuart Russell, Peter Norvig, *Artificial Intelligence – A Modern Approach*, (3e), Pearson Education, 2009.
2. Elaine Rich and Kevin Knight, *Artificial Intelligence*, (1e), McGraw-Hill,1990.
3. E Charniak and D McDermott, *Introduction to Artificial Intelligence*, (1e), Pearson Education, 2016.
4. Dan W. Patterson, *Artificial Intelligence and Expert Systems*, (1e), Prentice Hall of India, 1990.

EC4157: NEURAL NETWORKS & DEEP LEARNING [3 0 0 3]

Introduction: Various paradigms of earning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques. Feedforward neural network: Artificial Neural Network, activation function, multi-layer neural network. Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization. Conditional Random Fields: Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy. Deep Learning: Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network. Probabilistic Neural Network: Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Autoencoders. Deep Learning research: Object recognition, sparse coding, computer vision, natural language processing. Deep Learning Tools: Caffe, Theano, Torch, Matlab.

References:

1. Goodfellow, I., Bengio,Y., and Courville, A., *Deep Learning,* MIT Press, 2016.
2. Bishop, C., M., *Pattern Recognition and Machine Learning,* (1e), Springer, 2006.
3. Yegnanarayana, B., *Artificial Neural Networks*, (1e), PHI Learning Pvt. Ltd, 2009.
4. Golub, G., H., and Van Loan, C., F*., Matrix Computations*,(3e), JHU Press,1996.
5. Satish Kumar, *Neural Networks: A Classroom Approach,* (1e), Tata McGraw-Hill Education, 2009.
6. A. Ravindran, K. M. Ragsdell , and G. V. Reklaitis, *Engineering Optimization: Methods and Applications*, (2e), John Wiley & Sons, Inc. , 2006.
7. A. Antoniou, W. S. Lu, *Practical Optimization Algorithms and Engineering Applications,* (1e), Springer, 2007.

EC4158: ENERGY SOURCES & TECHNOLOGY [3 0 0 3]

Energy sources & Availability: Conventional, Non-conventional, renewable, non-renewable sources of energy, prospects & perspectives & advantages. Introduction to different types of non-conventional source of energy - solar, wind, biomass, OTEC, geothermal, hydrogen energy, fuel cells, MHD, thermonic convertor, thermoelectric power. Solar Radiation and Measurement: Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar isolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation. Solar time - Local apparent time (LAT), equation of time (E). Solar Radiation Geometry and Calculations, Prediction of solar radiation availability. Solar Electrical Energy Conversion: Solar photovoltaic energy conversion Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics. Wind Energy: Energy available from wind, basics of wind energy conversion system, windmill rotors, Fuel Cells. Principle & Classification, types conversion efficiency, polarization & advantages MHD power generation. Bio Energy: Types of biogas plants, biogas generation, factors affecting biogas generation, advantages and disadvantages. Ocean Energy: OTEC principle, open, closed and hybrid cycle OTEC system, advantages and disadvantages.

References:

1. S. P. Sukhatme and J. K. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, (3e), McGraw Hill Education, 2009.
2. J. A. Duffie, William A. Beckman, *Solar Engineering of Thermal Processes*, (4e), John Wiley, New York, 2013.
3. S. N. Singh, *Non-conventional energy resources*,(1e), Pearson India, 2015.
4. S. Kalogirou, *Solar Energy Engineering*, (2e), Elsevier/Academic Press, 2013.
5. D. Yogi Goswami, F. Krieth & J. F Kreider, *Principles of Solar Energy,* (2e), John Wiley, New York,1999.

EC4159: RF CIRCUITS AND COMPONENTS [3 0 0 3]

Review of Electromagnetic Theory, Transmission Lines and Waveguides, Impedance Matching and Tuning, Network Analysis. Introduction to Microstrip lines, Parallel Striplines, Coplanar Striplines, Shielded Striplines, Slot lines, Integrated Fin line, Non-radiative guide, Transitions, Bends and Discontinuities. RF circuits: Basic Architectures Transmission media and Reflections Resonant Circuits and RF Filter Design. High Frequency Amplifier Design.

Microwave Integrated Circuits (MIC): Technology of hybrid MICs, Design of MIC components transitions, couplers, Power dividers, oscillators, modulators, phase shifters and mixers.

References:

1. S. A. Maas, *Nonlinear Microwave and RF Circuits*, (2e), Artech, 2003.
2. David M. Pozar, *Microwave Engineering*, (4e), John Wiley & Sons, 2013.
3. G. Gonzales, *Microwave Transistor Amplifiers,* (2e), Pearson, 1996.
4. B.Bhat, S.K. Koul, *Stripline Like Transmission Lines For Microwave Integrated Circuits*, (1e), New Age Intl. Pvt Ltd., 2007.

EC 4160: DIGITAL IMAGE PROCESSING [3 0 0 3]

Basics of image processing: Fundamentals of digital image processing, image perception, Image sensing and acquisition, sampling and Quantization, image representation, basic relationship between pixels; Image enhancement and restoration: Basic grey level transformation, Histogram equalization, Image subtraction, Spatial smoothing and sharpening filters, Laplacian filters, Frequency domain smoothing and sharpening filters, Homomorphic filtering; Image restoration; Image transforms: Fourier transform, Fast Fourier Transform, Short Time Fourier Transform, Cosine Transform , discrete wavelet transform; Image Compression Algorithms and standards: Lossless and lossy compression: Variable length coding, LZW coding, Bit plane coding, predictive coding, DPCM, Transform coding, Wavelet coding, Basics of Image compression standards- JPEG, JPEG2000; Morphological processing and segmentation: Preliminaries, erosion, dilation, Hit-And-Miss transformation, Basic Morphological Algorithms; Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation; Color image processing: Color Fundamentals, Color Models, Pseudo color Image Processing, processing basics of full color image processing; Applications: Character recognition, Biomedical Image processing, Watermarking, multi-resolution analysis.

References:

1. R. C. Gonzalez, R. E. Woods, *Digital Image Processing*, (4e), Pearson Education, 2018
2. W. K. Pratt, *Digital Image Processing*, (4e), John Willey
3. A.K. Jain, *Fundamentals of Digital Image Processing*, (1e), PHI, New Delhi, 2004
4. K. R. Castleman, *Digital Image Processing*, Pearson Education, 2007
5. S. Sridhar, *Digital Image Processing,* Oxford Higher Education, 2013
6. S. Jayaraman, S. Esakkirajan, T. Veerakumar, *Digital Image Processing,* Mc Graw Hill, 2013

OPEN ELECTIVES

EC2080: INTRODUCTION TO COMMUNICATION SYSTEMS [3 0 0 3]

Optical Fiber Communications: Types of Optical Fibers, Numerical Aperture, Time Delay and Group Delay, Concept of V number, Attenuation and Dispersion (dispersion shifted and dispersion flattened fibers), Macro and Micro Bending, Pulse Broadening, Optical Sources and Detectors, Optical Communication System. Satellite Communications: Satellite orbits, Keplers laws, speed, period, angle of elevation, orbital effects in communication satellites, launching of a satellite, Earth Station technology, Space Segment, Modern Trends in Satellite Communications.

References:

1. J. M. Senior, *Optical Fiber Communications- Principles and Practise*, (3e), Pearson Education India, 2010.
2. R.P. Khare, *Fiber Optics and Optoelectronics*, (1e), Oxford University Press, 2004.
3. R. N. Mutagi, *Satellite Communications Principles and Applications*, (1e), Oxford University Press, 2016.
4. Wilbur L. Pritchard et al, *Satellite Communication Systems Engineering*, (2e), Prentice Hall, 1993.

EC2081: TRANSDUCERS AND INSTRUMENTATION [3 0 0 3]

Measurement, significance of measurement, instruments and measurement systems, mechanical, electrical and electronic instruments, Deflection & Null type instruments. Analog and digital modes of operation, applications of measurement systems. Transducers, Classifications of transducers, Factors influencing the choice of transducers/instruments. Dynamic response: dynamic characteristics, time domain analysis &different types of inputs, frequency domain analysis. Principles of Transduction, Variable resistance devices, Hall Effect Devices,

Proximity Devices, Digital Transducer, differential pressure level detector, float level devices. Force measuring sensor: Load cells, column types devices, proving rings, cantilever beam. Hydraulic load cell, Electronic weighing system. Transduction methods – potentiometric device, strain gauge transducer, variable reluctance, LVDT type, variable capacitance device.

References:

1. Alan S Morris, *Measurement and Instrumentation Principles*, (3e), Butterworth, 2001.
2. A. de Sa, Principles of Electronic Instrumentation,(2e),Butterworth-Heinemann, 1990.
3. David A. Bell, *Electronic Instrumentation and Measurements*, (3e), Oxford Press, 2013.
4. S. Tumanski, *Principles of Electrical Measurement,* (1e), Taylor & Francis, 2006.
5. Ilya Gertsbakh, *Measurement Theory for Engineers*, (1e), Springer, 2010.

EC2082: CONSUMER ELECTRONICS [3 0 0 3]

Audio Systems: Microphones, Head Phones and Hearing Aids, Loud Speakers, Loud Speaker Systems, Optical Recording and reproduction systems –CDs, DVDs, Blue ray technology, iPods, MP4 players and accessories, Home Audio systems. Television: Elements of TV Communication System, Scanning, Composite Video signal, Need for synchronizing and blanking pulses, Picture Tubes, Construction and working of Camera Tubes, Block diagram of TV Receiver, LCD and Plasma TV fundamentals, Block diagram and principles of working of cable TV and DTH. Telecommunication Systems: Basics of Telephone system, Caller ID Telephone, Intercoms, Cordless Telephones, Cellular mobile systems. Office electronics: Automatic Teller Machines, Facsimile machines, Digital Diaries, Safety and security systems. Home electronics: Digital Camera system, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators.

References:

1. S.P. Bali, *Consumer Electronics*, (1e), Pearson Education, 2005.
2. R.R.Gulati, *Monochrome and Color Television*, (2e), New Age International Publisher,2005.

EC2083: INTRODUCTION TO GAME THEORY [3 0 0 3]

Introduction Examples: Markets/ Politics/ Auctions. Prisoners' Dilemma, Best Response and Nash Equilibrium, Dominant Strategies, Stag Hunt – Coordination and Bank Runs. Multiple Nash Equilibria, Tragedy of Commons, Cournot Duopoly, Mixed Strategies, Battle of Sexes, Best Response Dynamic, Paying Taxes. Portfolio Management Game, Rationality, Choice and Common Knowledge, Iterated Elimination of Domination Strategies, Auction: As a Normal Form Game, Traffic at Equilibrium and Braess's Paradox. Extensive Form Games, Strategies in Extensive from Games, Sub Game Perfect Equilibrium, The Art of War, Ultimatum Game, Stackelberg Model. Bayesian Games, Bayesian Nash Equilibrium, Yield vs Fight, Bayesian Cournot Game, Bayesian Games with mixed strategies, Auctions, Sealed Bid First Price Auction, Expected Revenue, Bayesian Second Price Auction, Second Price Auction, All Pay Auction. Evolutionary Biology, Evolutionary stable Strategy (ESS), Repeated Games, Multiple Equilibriums, Chain-Store Paradox, Non – Cooperative Bargaining; Extensive Form Game with Incomplete Information, Introduction to perfect Bayesian Equilibrium, Obtaining PBE, Gift Game.

References:

1. Martin Osborne, *An Introduction to Game Theory*, (1e), Oxford University Press, 2003.
2. Ken Binmore, *Game Theory*: A *Very Short Introduction*, (1e), Oxford University Press, 2007.

EC3080: ELECTRONIC MEASUREMENT & MEASURING INSTRUMENTS [3 0 0 3]

Basics of Measurements: Fundamental & Importance of Instrumentation, types of instruments, selection of instruments, performance of instruments, error in measurement, calibration & standard, Calibration of Instruments: Methods & analysis, Introduction to Transducer & types. Analog DC and AC meters: Electromechanically meter movements, PMMC, Analog DC ammeters, Analog DC voltmeters, Analog AC ammeters and Voltmeters, Analog multimeters, Special purpose analog meters, Use of basic meters, meter errors, problems. Extending the range of meters, Loading effects and their elimination, true rms voltmeters. Digital Meters: DVM and Digital multimeter, vector voltmeters, 7 segment and LCD display. Analog to Digital Converters and Digital to Analog Converters. Oscilloscope: Oscilloscope subsystem, Principle of Operation, Cathode Ray Tube ,Display subsystem, Vertical deflection subsystem, Dual trace/Dual beam feature, Horizontal deflection subsystems, oscilloscope probes, oscilloscope controls, Front panel of an oscilloscope, Lissajous patterns oscilloscope photography, Digital storage oscilloscopes (DSO), Power scope. Attenuation probes, problems.

References:

1. W. D. Cooper and A. D. Helstrick, *Modern Electronics Instrumentation & Measurement Techniques*, (4e), Pearson, 1990.
2. J. J. Carr., *Elements of Electronics Instrumentation and Measurement*, (3e), Pearson, 2003.
3. M. M. S Anand, *Electronics Instruments and Instrumentation Technology*, (1e), PHI, 2009.
4. E.O. Deoblin, *Measurement Systems*, (4e), Mcgraw Hill, 1990.
5. S. Wolf & R.F.M Smith, *Student Reference Manual for Electronic and Instrumentation Measurement*, (2e), PHI Publication, 2004.

EC3081: ELECTRONIC PRODUCT DESIGN & PACKAGING [3 0 0 3]

Industrial design: Product planning, Creativity, Aesthetics, Ergonomics, control panel organization, Product detailing, Product finishes. Thermal management: Introduction to thermal sources, heat calculations, heat transfer methods, heat sink selection, cooling methods in electronic systems. Packaging Techniques: Introduction to Electronic Packaging, Microelectronics and Packaging Technologies, Introduction to Silicon Integrated Circuit Chips, Semiconductor Devices, Area Array Technologies: Ball Grid Arrays, Flip Chip, Chip-Scale Packaging, First Level Packages-IC packaging. Second Level Packages: Printed Circuit Boards and Other Substrates; Third Level Packages: Connectors, Cables, Modules, Cages and Cabinets, Reliability Prediction and Measurement. Noise and EMI: Introduction to Noise and EMI, Interfacing of analog and digital systems. PCB design and layout; System assembly considerations, Sources of EMI, Shielding of signal lines, Ground loops, Introduction to functional aspects of SMPS and other power electronic equipment.

References:

1. C. H. Flurshiem, *Industrial design and Engineering*, (1e), Springer Verilog, 1983.
2. P. Horowitz, W Hill, *The art of electronics*, (2e), Cambridge, 1995.
3. H.W. Ott, *Noise Reduction Techniques in Electronic Systems*, (2e),Wiley, 1988.
4. W.C. Bosshart, *Printed Circuit Boards: Design and Technology*, (1e),Tata McGraw Hill, 1992.

EC3082: ADVANCED FUNCTIONAL DEVICES TECHNOLOGY [3 0 0 3]

Introduction of present scenario, Introduction to Smart and Functional Materials, Properties of active materials and their assessment. Application: temperature, strain, stress, magnetic field, electrical field, mechanical quantities, adaptive structures. MEMS/NEMS Actuators: piezo-actuators for advanced robotics and sonar communications, Organic and inorganic semiconductor devices. Energy: solar cells, solar absorbers, perovskite solar cells, piezoelectric energy harvesting. Biomedical devices: Digital microfluidics, Lab-on-chip and Cancer detection devices and treatment using Nano particles etc. Recycling Technique: Electronic Waste, Acceptance of new materials and systems in industry: Process and materials optimization, Economic models, Standardization, Future perspectives.

References:

1. William A. Goddard III, Donald Brenner, Sergey Edward Lyshevski, Gerald J Iafrate, *Handbook of Nanoscience, Engineering, and Technology*, (3e), CRC press, 2012.
2. Roger J Narayan, *Medical Biosensors for Point of Care (POC) Applications*, (1e), Elsevier, 2016.
3. Bent Sørensen, *Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning*, (4e), Academic Press, 2010.
4. Hugo Marcelo Veit, Andréa Moura Bernardes, *Electronic Waste: Recycling Techniques, (1e), Springer; 2015.*
5. Vlad-Victor Oncescu, *Development of Point-of-care Devices for Rapid Diagnostics and Preventive Care, 2014.*

EC3083: MOBILE CELLULAR COMMUNICATION [3 0 0 3]

Global system for Mobile Communication (GSM) system overview: GSM Architecture, Mobility Management, Network signalling. General Packet Radio Services (GPRS): GPRS architecture, GPRS Network nodes. Overview of Cellular Systems and Evolution 2G/3G/4G/5G. Cellular Concepts Frequency Reuse, Cellular Capacity, Capacity Building, Cochannel and Adjacent Channel Interference, ,C/I, Handoff, Hidden and Exposed Node problems for Medium Access Control. Improvement of Coverage Capacity (cell splitting, cell sectoring, microzoning). Wireless Propagation. Free Space path Loss, Refraction, Diffraction and Scattering, Link Budget, Multipath Fading (small scale, large scale, multipath propagation, Rayleigh and Ricean Fading), Shadowing. Diversity Techniques including Antenna

Diversity. Introduction to MIMO, OFDMA techniques, UHF and Millimeter Wave Communications . Channel Models and Large Scale Propagation effects.

References:

1. Yi –Bing Lin & Imrich Chlamatac, *Wireless and mobile Networks Architecture*, (1e), John Wiley & Sons, 2001.
2. Raj Pandya, *Mobile & Personnel communication Systems and Services*, (1e), Prentice Hall India, 2001.
3. Theodore S. Rappaport, *Wireless Communication- Principles and practices*, (2e), Pearson Education Pvt. Ltd, 2003.
4. Jochen Schiller, *Mobile communications,* (2e),Pearson Education Pvt. Ltd., 2009.
5. Singhal & Bridgman et. Al, *The Wireless Application Protocol*, (1e), Pearson Education, 2000.

EC3084: AUDIO & VIDEO SYSTEMS [3 0 0 3]

Basic Components of Audio and Video: Construction & Working of Microphone, types of microphone, Construction & Working of Loud Speaker, Tweeter, Wooffer, Mid range, CCD Camera. HI-FI and Stereophony : Meaning of Hi-Fi, Basic components, Fundamental of sound harmonics, Loudness, Pitch, Timbre, Sensitivity, Stereophony recording, Broadcasting of stereophony and its reproduction, Graphic equalizer, Basic idea about audio pre amplifier and power amplifiers. Scanning and Composite Video Signal : Scanning Process, Flicker & Inter lace scanning, Contrast Ratio & Aspect ratio and viewing distance, Composite Video signal dimensions, Horizontal and vertical sync details, TV standards for 625 line system. Basics of T.V. Signal Transmission & Reception: Block diagram of TV transmitter and TV Receiver. Colour T.V.: Introduction to Colour T.V. & colour T.V. Essentials. Basic Concept of New Trends : Audio CD player, Audio conferencing, Digital versatile disk (DVD), Home theatre system, LCD & LED TV, Plasma TV, Blue ray disc.

References:

1. A.K. Sawhney, *A Course in Electrical & Electronic Measurement & Instruments*, (7e), Dhanpat Rai pvt ltd, 2015.
2. B. Grob, C. E. Herndon, *Basic Television & Video System*, (6e), McGraw-Hill, 1999.
3. R. G. Gupta, *Audio and Video Systems- Principles, Maintenance and Troubleshooting*, (2e), McGraw Hill Education Limited, 2010.
4. R.R. Gulati, *Monochrome & Colour TV System*, (3e), New age International, 2009.
5. R. R. Gulati, *Modern Television – Practice, Principles, Technology & Servicing*, (3e), New age International, 2007.
6. A.M. Dhake, *T.V. and Video Engineering*, (2e), McGraw Hill Education Ltd, 2000.

EC3085 OPTICAL FIBRE TECHNOLOGY [3 0 0 3]

Optical fibre, Types of fibres, Step index and graded index fibres, Characteristics of optical fibre, Input, output couplers. Optical fibres and cables: Fabrication of optical fibre, Fibre drawing, Vapour phase deposition techniques, Cable design Optical fibre connection: joints and couplers Fibre splices, fusion splices, mechanical splices, Fibre connectors, expanded beam connectors, Fibre couplers,Source to fibre and fibre to fibre coupling, Coupling losses. Transmission characteristics of optical fibres: Attenuation, absorption losses, linear scattering losses, nonlinear scattering losses, Stimulated Raman and stimulated Brillouin scattering, Fibre bend losses. Dispersion: Phase and group velocities, Material dispersion, intramodal dispersion and wave guide dispersion, Overall fibre dispersion. Dispersion modified fibres; Optical Fibre sensors: Intensity modulation sensors, Phase modulation sensors, Temperature, pressure, chemical and rotation sensors, Fibre optic gyroscopes, Evanescent wave sensors.

References:

1. Ajoy Ghatak and K. Thyagarajan, *Introduction to fiber optics*, (1e), Cambridge UnivPress, 1998.
2. John M Senior, *Optical Fiber communication,* (3e), Pearson, 2009.
3. Clifford R. Pollock and Iswing, *Fundamentals of Opto electronics,* (1e), Richard d Irwin, 1994.
4. J. Palais, *Fiber optic communication,* (1e), PHI, 1998.
5. B.P.Pal, *Fundamentals of fibre optics in communication,* (1e), Wiley Eastern, 1995.

EC3086: SOLAR PHOTOVOLTAIC TECHNOLOGY [3 0 0 3]

Photovoltaic Basics: Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays - Basics of Load Estimation. Stand Alone PV Systems: Schematics, Components, Batteries, Charge Conditioners - Balance of

system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc. Grid Connected PV Systems: Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings. Hybrid Systems: Solar, Biomass, Wind, Diesel Hybrid systems - Comparison and selection criteria for a given application. Design of PV Systems: Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies.

References:

1. C. S. Solanki, *Solar Photovotaics – Fundamentals, Technologies and Applications*, (2e), PHI Learning Pvt. Ltd., 2011.
2. A. L. Fahrenbruch and R. H. Bube, *Fundamentals of Solar Cells*, (1e), Academic Press, New York, Elsevier, 1983.
3. M. A. Green, *Solar Cells Operating Principles, Technology and System Applications*, (1e), Prentice-Hall, 1981.
4. J. Nelson, *The Physics of Solar Cells,* (1e), Imperial College Press, 2003.
5. M. Thomas, *Solar Electricity*, (2e), John Wiley and Sons, 2000.
6. S. R. Wenham, Martin A. Green, Muriel E. Watt, Richard Corkish (Editors), *Applied Photovoltaics,* (2e), Routledge, 2006.
7. M. Boxwell, *The Solar Electricity Handbook*, Code Green Publishing, UK, 2018.
8. R. DeGunther, *Solar Power Your Home for Dummies*, (1e), Wiley Publishing Inc, 2008.
9. *Photovoltaics: Design and Installation Manual,* (1e),New Society Publishers, 2004.

EC3087: HYBRID SOFT COMPUTING TECHNIQUES [3 0 0 3]

Neural Network: History, structure and function of single neuron, neural net architectures, neural learning, use of neural networks, supervised learning networks, Associative memory networks, unsupervised learning networks, Special networks like Simulated Annealing Network, Cascade Correlation network, and Optical neural network. Applications of Neural Network. Engineering optimization: Introduction to optimization, Genetic algorithms, Simulated Annealing, Particle swarm optimization, Ant colony optimization, Fuzzy based optimization techniques, Neural network based optimization techniques.

References:

1. S. S. Rao, *Engineering optimization theory and practice*, (4e), John Wiley & Sons, 2009.
2. S.N. Deepa, S.N. Sivanandam, *Principles of Soft Computing*, (2e), Wiley, 2011.
3. S.N. Sivanandam, S. Sumathi, S. N. Deepa, *Introduction to Fuzzy Logic using MATLAB, (1e),* Springer-Verlag Berlin Heidelberg, 2007.
4. S. Rajasekaran, G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic, and Genetic Algorithms : Synthesis and Applications, (1e),* PHI, 2013.
5. Samir Roy, Udit Chakraborty, *Soft Computing: Neuro-Fuzzy and Genetic Algorithms,* (1e), Pearson, 2013.
6. Kalyanmoy Deb, *Optimization for Engineering Design: Algorithms and Examples*, (2e), PHI, 2013.
7. Dr. Shailendra Jain, *Modeling and Simulation using MATLAB – Simulink, (2e),* Wiley, 2015.
8. Rajjan Shinghal, *Introduction to Fuzzy Logic, (1e),* PHI, 2013.

DEAPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

The department of Electrical Engineering (EE) was established in the year 2011. The mission of EE department is to provide quality education at undergraduate & post graduate level in Electrical & Electronics Engineering. To carry out quality research at the cutting edge technologies in order to meet future technological challenges. In pursuit of this, it is aimed to create concrete technical foundation and extend commitment in providing State of the Art Interactive Education. It shares the mission and the vision of the institution in imparting high quality education and practical aspects to the students. The department is offering various programs at UG, PG and Ph.D. level. The broad emphasis of the teaching at EE department is design aspects and modern trends of Power System, Power Electronics, Electrical Machines, Control Systems etc. The EE department has highly qualified, committed and experienced faculty members working in the recent research areas related to electrical and electronics engineering. The laboratories are well equipped with State-of-Art facilities in diversified field such as Electrical Machines, Power Systems, Control Systems, Advanced Power Electronics, Electrical Measurements & Instrumentation.

The EE department has signed Memorandum of Understandings (MoUs) with Secure meters Pvt. Ltd. Udaipur, Multimedia University Malaysia, Esigelec France, IATC SIEMENS Chandigarh, CEERI Pilani, BSNL ALT Ghaziabad etc. The focus is more on hands-on training than theory, and therefore, to bridge the gaps between academic-industry needs and to promote the collaborative research in areas of common interests.

The EE department provides a platform for our students in the form of a student club named as TECHNOELECTRICIA. This student club facilitates various students' activities to the frontiers of knowledge, such as hands-on training workshops, international conferences, invited talks, etc. It also deliberates the technical issues and their solutions for the societal benefit and also disseminate awareness for the safe & productive utilization of technological comfort in human life.

B.Tech in Electrical & Electronics Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value Ethics & Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA2103	Engineering Mathematics – III	2	1	0	3	MA2205	Engineering Mathematics – IV	2	1	0	3
	EC2101	Signals & Systems	3	0	0	3	EC2201	Analog Integrated Circuits & Systems	3	0	0	3
	EC2102	Analog Electronics	3	1	0	4	EC2202	Microprocessors & Microcontrollers	3	1	0	4
	EC2103	Digital System Design & Computer Architecture	3	1	0	4	EC2203	Digital Signal Processing	3	1	0	4
	EC2104	Electromagnetic Field Theory	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	EC2130	Analog Electronics Lab	0	0	2	1	EC2230	Electronic Sub-System Design Lab	0	0	2	1
	EC2131	DSD & HDL Lab	0	0	2	1	EC2231	Digital Signal Processing Lab	0	0	2	1
	EC2170	Project Based Lab - I	0	0	2	1	EC2232	Microprocessors & Microcontrollers Lab	0	0	2	1
							EC2270	Project Based Lab - II	0	0	2	1
			16	4	6	23			17	3	8	24
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P) + OE		28			
	FIFTH SEMESTER						SIXTH SEMESTER					
III	BB0026	Organisation and Management	2	1	0	3	EC3201	Microwave Engineering	3	0	0	3
	EC3101	Antennas	3	1	0	4	EC3202	Embedded & Real Time Operating Systems	3	1	0	4
	EC3102	Network & Control Theory	3	1	0	4	EC3203	Optical Communication	3	1	0	4
	EC3103	Analog & Digital Communication	3	1	0	4	EC32XX	Program Elective – I	3	0	0	3
	EC3104	CMOS VLSI Design	3	1	0	4	EC32XX	Program Elective – II	3	0	0	3
	XXXXXX	Open Elective – II	3	0	0	3	XXXXXX	Open Elective – III	3	0	0	3
	EC3130	VLSI Lab	0	0	2	1	EC3230	Embedded & RTOS Lab	0	0	2	1
	EC3131	Analog & Digital Communication Lab	0	0	2	1	EC3231	Antenna & Microwave Lab	0	0	2	1
	EC3170	Project Based Lab - III	0	0	2	1	EC3232	Optical Communication Lab	0	0	2	1
							EC3270	Minor Project-I	0	0	2	1
			17	5	6	25			18	2	8	24
	Total Contact Hours (L + T + P) + OE		28				Total Contact Hours (L + T + P) + OE		28			
	SEVENTH SEMESTER						EIGHTH SEMESTER					
IV	EC41XX	Program Elective – III	3	0	0	3	EC4270	Major Project	0	0	0	12
	EC41XX	Program Elective – IV	3	0	0	3						
	EC41XX	Program Elective – V	3	0	0	3						
	EC41XX	Program Elective – VI	3	0	0	3						
	EC41XX	Program Elective – VII	3	0	0	3						
	EC4170	Minor Project - II	0	0	2	1						
	EC4171	Industrial Training	0	0	2	1						
			15	0	4	17			0	0	0	12
	Total Contact Hours (L + T + P)		19				Total credits=169(including credits of first year)					

THIRD SEMESTER

BB0025: VALUE EHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX. Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects. CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B. N. Ghosh, *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. S. K. Mandal, *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. C. K. Ray, *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. A. Chatterjee, *Professional Ethics*, (2e) Oxford Publications.

MA2103: ENGINEERING MATHEMATICS – III [2 1 0 3]

Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Periodic function, Fourier series expansion. Even and odd functions, functions with arbitrary periods, half range expansions, Fourier transform, Parseval's identity, PDE-Solution by method of separation of variables and by indicated transformations. One dimensional wave equation, one dimensional heat equation and their solutions. Vector differential operator, gradient divergence and curl. Line, surface and volume integrals. Green's theorem, Divergence and Stoke's theorem.

References:

1. B. S. Grewal, *Higher Engineering Mathematics*, (43e), Khanna Publishers, 2014.
2. E. Kreyszig, *Advanced Engineering Mathematics*, (7e), John Wiley & Sons, Inc., 2015.
3. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, (7e), Pearson Education, 2007
4. R. Spiegel Murray, *Vector Analysis*, (2e), Schaum Publishing Co., 2009.

EE2101: ANALOG & DIGITAL SYSTEM DESIGN [3 1 0 4]

Semiconductor Devices MOSFET Characteristics, structure, biasing, current mirrors, basic amplifier configurations, CS, CD, CG configurations, small signal model, frequency response, OPAMP configuration, OPAMP in linear Mode, OPAMP with positive and negative feedback, Linear applications of OPAMP, Nonlinear applications of OPAMP, Overview of Algebraic simplification of Boolean expressions, realization using logic gates, minimization using Karnaugh map, Combinational circuit design, Arithmetic circuits, Sequential logic circuits: Overview of flip-flops, Counters, shift registers.

References:

1. D. S. William, *Operational Amplifiers with Linear Integrated Circuits*, Pearson Education, 2004.
2. Boylestad and Nashelsky, *Electronic Devices and Circuit Theory* (10e), Pearson Education 2009.
3. R. A. Gayakwad, *Op-Amps and Linear Integrated Circuits* (4e), Pearson Education 2015.
4. D. D. Givone, *Digital Principles & Design*, TMH Publications, 2003.
5. J. F. Wakerly, *Digital Design Principles & Practices*, Pearson Education, 2002

EE2102: ELECTROMAGNETIC FIELD THEORY [2 1 0 3]

Vector analysis: Vector algebra, Rectangular, Cylindrical and Spherical Coordinates, Electrostatics: Field intensity, Flux density, Electric scalar potential, Potential gradient, Energy density in an electric field, Boundary conditions,

Capacitance, Laplace's and Poisson's equations. Magnetostatics: Field intensity, Flux density, Boundary conditions, Magnetic forces, Inductance, Time varying fields: Maxwell's equations, Uniform Plane wave: Wave equation and its solution, Wave propagation in different media, Poynting's theorem.

References:

1. W. Hayt, *Engineering Electromagnetics*, TMH, 2012.
2. M. Sadiku, *Elements of Electromagnetics*, Oxford University Press, 2014.
3. N. Rao, *Elements of Engineering Electromagnetics*, Pearson Education, 2006.

EE2103: ELECTRICAL CIRCUIT ANALYSIS [3 1 0 4]

Introduction to Graph Theory, Graph of a network, Matrix representation of a graph, Cut- set and Tie set Matrix. Network Theorems with controlled sources: Superposition, Thevenin's, Norton's, Maximum power transfer, Reciprocity, Substitution, Compensation, Millman's, Tellegen's theorems. Signals and waveforms: Classification of Signals, elementary signals, characteristics, representation of waveforms. Time domain analysis: Initial and final conditions, Transients analysis of RL, RC and RLC circuits. Frequency domain analysis: Laplace domain analysis, Laplace Transforms of signals, Transformed circuits, Analysis of networks using Laplace Transforms, Frequency domain analysis: Network Function, poles and zeros, convolution integral. Two port networks: Z, Y, T and h parameters, Relation between parameters, Series, parallel and cascade connections.

References:

1. W. H. Hayt, J. E. Kemmerly & S. M. Durbin, *Engineering Circuit Analysis*(7e), TMH, 2010.
2. V. Valkenberg*, Network Analysis* (3e), PHI, 2009.
3. J. W. Nilsson & S. A. Reidel, *Electric Circuits* (9e), PHI, 2011.
4. R. R. Singh, *Network Analysis and Synthesis*, McGraw Hill Education 2013

ELE 2104: ELECTRICAL MACHINES – I [3 1 0 4]

Transformers: Types of transformers; Single phase transformers - working principle, construction, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency, All day efficiency, testing, parallel operation, inrush current, harmonics, tap changing, auto transformer. Three phase transformers: Connections: star-star, star-delta, delta-star, delta-delta, zigzag, open delta; three winding transformer. DC Machines: DC generators- working principle, construction, types, armature winding, Magnetization characteristics, armature reaction, commutation, load characteristics, DC Motors – working principle, types, torque-speed characteristics, starting, braking, speed control, losses, efficiency, and testing. BLDC motors – working principle and control.

References:

1. A. E. Clayton & N. N. Hancock, *Performance and Design of Direct Current Machines*, CBS, 2004.
2. Fitzarald & Kingslay, *Electric Machinery*, TMH, 2011
3. P. S. Bhimbra, *Electrical Machinery*, Khanna Publication, 2011
4. D. P. Kothari & I. J. Nagrath, *Electric Machines* (4e), TMH, 2013.

EE2130: ANALOG SYSTEM DESIGN LAB [0 0 2 1]

Module I: Design, Simulate and Test basic analog electronic circuits using diodes, Rectifiers without and with capacitor filter, Fixed and variable voltage power supplies, Zener diodes, voltage regulators, MOSFET biasing and current mirror circuits, Frequency response of Amplifier Circuits, Power amplifiers, Differential amplifier circuit. Module II: Design, Simulation and Testing of operational amplifier based circuits in linear and nonlinear mode, Timer based Mono-stable and Astable-Multivibrators circuits.

References:

1. B. Razavi, *Fundamentals of Microelectronics* (2e), Wiley Publishers, 2013.
2. S. Franco, *Design with Operational Amplifiers and Analog Integrated Circuits* (4e), McGraw-Hill, 2014.
3. A. S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, *Microelectronic Circuits: Theory and Application* (6e), Oxford, 2017.

EE2131: DIGITAL SYSTEM DESIGN LAB [0 0 2 1]

Design and Testing of combinational circuits using gates, multiplexers, decoders, arithmetic circuits etc., Design and Testing of sequential digital electronic circuits such as counters, shift registers & sequence generators, sequence detectors etc. HDL and Digital Circuit Implementation on FPGA.

References:

1. Givone, *Digital Principles & Design*, TMH, 2011.
2. Wakerly, *Digital Design Principles & Practices*, Pearson, 2003.
3. C. H. Roth, *Fundamentals of Logic Design*, Jaico, 2007.
4. S. Brown and Z. Vranesic, *Fundamentals of Digital logic with Verilog design*, TMH, 2008.

EE2132: ELECTRICAL MACHINERY LAB – I [0 0 2 1]

Transformers: OC and SC tests on single phase transformer, Sumpner's test, Polarity tests, connection of single phase transformers as three phase bank, Scott-connection of transformer, Parallel operation of single phase transformers. DC Machines: Magnetisation characteristics of DC generator, Load test on dc machines, speed control of D.C. shunt motor. Testing of DC Machines. BLDC motors – operation and control.

References:

1. E. H. Langsdorf, *Theory of Alternating Current Machinery* (2e), TMH, 2004.
2. A. E. Clayton & N. N. Hancock, *Performance and Design of Direct Current Machines*, CBS, 2004.
3. Fitzarald & Kingslay, *Electric Machinery*, TMH, 2011
4. P. S. Bhimbra, *Electrical Machinery*, Khanna Publication, 2011
5. D. P. Kothari & I. J. Nagrath, *Electric Machines* (4e), TMH, 2013.

FOURTH SEMESTER

EO2001: ECONOMICS – IV [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H. L. Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H. C. Peterson, *Managerial Economics*, (9e), 2012.
3. P. L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G. J. Tuesen and H.G. Tuesen, *Engineering Economics*, PHI.
5. J. L. Riggs, D. D. Bedworth and S. U. Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA2206: ENGINEERING MATHEMATICS – IV [2 1 0 3]

Statistics: Mean, Median, Mode measures of dispersion. Finite sample spaces, conditional probability and independence, Bayes' theorem, one dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions. Moment generating function, Functions of one and two dimensional random variables, Sampling theory, Central limit theorem. Difference equations with constant coefficients, solutions. Z- Transforms and Inverse Z-transforms. Solutions of Difference equations using Z-transforms. Solution of boundary value problems, Numerical solutions of Laplace and Poisson equations, heat and wave equations by explicit methods.

References:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. A. V. Openheim & R. W. Schafer, *Discrete Signal Processing*, Prentice Hall, 2009.
3. R.V. Hogg and A.T. Craig, *Introduction to Mathematical Statistics* (4e), MacMillan, 2012.
4. R. Narayanan and M. Pillay, *Advanced Engineering Mathematics*, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd, 2006.

EE2201 Electrical Machinery – II [3 1 0 4]

Induction Machines: Three phase Induction motor- construction and working principle, equivalent circuit and phasor diagram, losses and efficiency, torque-slip characteristics, no load & blocked rotor tests, starting, braking, speed control, Induction generator, Single phase induction motor - types, double field revolving theory, torque-slip characteristics. Synchronous Machines: Alternators– construction and working principle, EMF equation, Equivalent circuit of non-salient pole alternator, Phasor diagrams, voltage regulation, Synchronization, Synchronizing power and torque, power angle characteristics, Load sharing, Alternator connected to infinite bus, Equivalent circuit of salient pole alternator - Two reaction theory, Phasor diagrams, slip test. Synchronizing power and torque, power angle characteristics. Synchronous motors: working principle, Starting methods, Synchronizing power and torque, Performance characteristics, Hunting, Synchronous condenser.

References:

1. E. H. Langsdorf, *Theory of Alternating Current Machinery* (2e), TMH, 2004.
2. A. E. Clayton & N. N. Hancock, *Performance and Design of Direct Current Machines*, CBS, 2004.
3. D. P. Kothari & I. J. Nagrath, *Electric Machines* (4e), TMH, 2013.
4. Fitzarald & Kingslay, *Electric Machinery*, TMH, 2011
5. P. S. Bhimbra, *Electrical Machinery*, Khanna Publication, 2011

EE2202: GENERATION TRANSMISSION & DISTRIBUTION [3 1 0 4]

Generation of Electric Power: Hydro Electric Power Plants, Thermal and Nuclear Power Plants, Diesel Power Plant, Typical AC transmission and distribution scheme: Effect of system voltage and regulation, Distribution network elements, distribution schemes, Transmission Line Parameter Calculations, Transmission Line Performance, Ferranti effect, receiving end power circle diagram, regulated system of transmission by reactive power control, power factor improvement, Mechanical characteristics of Overhead lines: Line Insulators, Corona, Underground cables.

References:

1. J. Duncan Glover, Mulukutla S Sarma and Thomas J Overbye, *Power System Analysis and Design*, (5e), Cengage Learning, 2012.
2. S. N. Singh, *Electric Power Generation, Transmission & Distribution* (6e), PHI, 2011.
3. D. P. Kothari & I. J. Nagrath, *Power System Engineering* (2e), TMH, 2010.
4. C. L. Wadhwa, *Electrical Power System* (3e), New Age Intl, 2013.
5. B. R. Gupta, *Power System Analysis and Design* (7e), S. Chand Publications, 2014.

EE2203: MICROCONTROLLERS [2 1 0 3]

Introduction to microprocessors and microcontrollers, general purpose and embedded systems, CISC and RISC architectures, AT89C51 (8051) microcontroller: Architecture, pin diagram, addressing modes, instruction set, programming, stack, subroutines, GPIO, timers, serial port, interrupts. Interfacing keyboard, LCD, ADC and DAC to 8051. Embedded software development in 'C'. Programming 8051 in 'C'. ARM7 based NXPLPC21XX microcontroller: architecture, programming and interfacing.

References:

1. M. A. Mazidi and G. Mazidi, *The 8051 Microcontroller and embedded systems, using assembly and 'C'*, Pearson education, 2013.
2. K. Ayala, *The 8051 Microcontroller and embedded systems, using assembly and 'C'*, Cengage Learning, 2009.
3. S. Furber, *ARM System - on – Chip Architecture* (2e), Pearson, 2015.
4. W. Hohl and H. Christopher, *ARM Assembly Language*, CRC Press, 2016.

EE2230: ELECTRICAL MACHINERY LAB – II [0 0 2 1]

Induction machines: No load and blocked rotor tests, Load test on three phase squirrel cage & Slip ring Induction motor, Load test on induction generator. Load test on Single Phase Induction Motor. Synchronous Machines: V- and inverted V-curves of synchronous machines, Measurement of Xd and Xq of a salient pole synchronous

machine, Predetermination of regulation of alternator. Synchronization of alternator, Design of Electrical machines.

References:

1. E. H. Langsdorf, *Theory of Alternating Current Machinery* (2e), TMH, 2004.
2. A. E. Clayton & N. N. Hancock, *Performance and Design of Direct Current Machines*, CBS, 2004.
3. Fitzarald & Kingslay, *Electric Machinery*, TMH, 2011
4. P. S. Bhimbra, *Electrical Machinery*, Khanna Publication, 2011
5. D. P. Kothari & I. J. Nagrath, *Electric Machines* (4e), TMH, 2013.

EE2231: MICROCONTROLLER LAB [0 0 2 1]

Module I: Experiments using 8051 Microcontroller simulator. Module II: Interfacing exercises using 8051 microcontroller, Module III: Experiments using ARM7 processor based microcontroller.

References:

1. M. A. Mazidi and G. E. Mazidi, *The 8051 Microcontroller and embedded systems, using assembly and 'C'*, Pearson education, 2013.
2. K. J. Ayala*, The 8051 Microcontroller and embedded systems, using assembly and 'C'*, Cengage Learning, 2009.
3. S. Furber, *ARM System - on -Chip Architecture* (2e), Pearson, 2016.

EE2232: MATLAB & SYSTEM SIMULATION LAB [0 0 2 1]

Introduction to MATLAB, Basics of MATLAB matrices and vectors, matrix and array operations, Saving and loading data, plotting simple graphs, scripts and functions, Script files, Function files, Global Variables, Loops, Branches, Control flow, Advanced data objects, Multi-dimensional matrices, Structures, Electric circuit simulation using MATLAB, data visualization, functions, file I/O and GUI, Introduction to SIMULINK, Steady state analysis of circuits, Transient analysis of RL, RC, and RLC circuits, Circuit simulation using Simscape. Simulation of basic electrical systems: PV System, Distribution System, Electrical vehicle system.

References:

1. D. Hanselman, *Mastering MATLAB 7*, Pearson Education, 2005.
2. S. J. Chapman, *Essentials of MATLAB Programming*, BAE Systems (3e), Cengage Learning, 2008.
3. A. Gilat, *MATLAB: An Introduction with Applications*, Wiley India Ltd., 2004
4. S. L. Eshkavilov, *MATLAB & Simulink Essentials: MATLAB & Simulink for Engineering Problem Solving and Numerical Analysis*, Lulu Publishing, 2017.

FIFTH SEMESTER

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower**.** Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit**.** Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

References:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, Essentials of Management (1e),

Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, P. Stephen, and Mary Coulter, Management, Prentice Hall, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, Modern Production / Operations Management, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, Organizational Behavior, McGraw – Hill, 1986.
5. K. Aswathappa, Human Resource and Personnel Management, Tata McGraw Hill, 2005.
6. W. Wether & K. Davis, Human Resource and Personnel Management, McGraw Hill, 1986.

EE3101: COMMUNICATION SYSTEMS [2 1 0 3]

Elements of communication systems; Analog Communication techniques : Amplitude modulation Schemes, Angle (Non-Linear) Modulation; Pulse Modulation schemes ; Data transmission using analog carriers- Shift Keying techniques ; Channel Encoding & decoding technologies; Conceptual idea of encryption & decryption; Communication Protocols& Networking; Internet of Things; Wireless sensor actuator networks, Applications: Spread Spectrum & Mobile Communications - Optical fiber communication, Basic principles of Digital TV Broadcasting.

References:

1. S. Haykin, and Michael Moher, *Introduction to analog & digital communications*, John Wiley & Sons. 2007.
2. S. Haykin, *Communication systems*, John Wiley & Sons, 2008.
3. W. Stallings, *Cryptography and network security: principles and practices*, Pearson Education India, 2006.
4. D. Torrieri*, Principles of spread-spectrum communication systems*, Springer, 2015.

EE3102: DIGITAL SIGNAL PROCESSING [3 1 0 4]

Time domain analysis of discrete-time signals & systems: linear-time invariant systems, impulse response, convolution, causality and stability, representation of LTI systems, Frequency domain analysis of discrete-time signals and systems: Discrete-time Fourier series, Discrete-time Fourier transform, properties and applications, Z transform representation of discrete time signals and systems, properties and applications. Sampling in time and frequency domain. Discrete Fourier Transform-Linear convolution using DFT. Computation of DFT-Fast Fourier Transform, Decimation in time and Decimation in frequency FFT algorithms. Digital Filters-Digital filter structures, FIR and IIR filters. FIR filter design- FIR design by Fourier approximation, Window method, Frequency sampling method, Optimal FIR design. IIR filter design: Classical filter design using Butterworth and Chebyshev approximations, Impulse invariant and bilinear transformation methods, Frequency transformation technique for HP, BP and BS filter design. Direct design of IIR filters. Applications of DSP.

References:

1. S. Haykin, *Signals and Systems*, Wiley, 2007.
2. A. V. Oppenheim, Alan S. Willsky, and S. Hamid Nawab, *Signals and Systems* (2e), PHI, 2014.
3. J. G. Proakis and D.G. Manolakis, *Introduction to Digital Signal Processing*, PHI, 2009.
4. A. V. Oppenheim and R.W. Schafer, *Discrete time signal processing*, Pearson, 2009.
5. S. K. Mitra, DSP: A computer based approach (2e), TMH, 2006.

EE3103: MEASUREMENTS & INSTRUMENTATION [3 1 0 4]

Electrical instrumentation, characteristics, electromagnetic interference, instrumentation transformers, Moving Coil and Moving Iron Instruments, Bridge circuits for R, L and C measurements, Modern Transducers for R, L and C measurements, Signal Isolation (Magnetic and Optical), Charge amplifiers, Instrumentation amplifiers, Active filters, Sallen Key Topology, State Variable Filters, Sample & Hold circuits, Successive Approximation, Flash A/D Converter, PWMD/A converter, R 2R and Binary weighted D/A converter, Net metering concepts, Phasor Measurement Unit.

References:

1. K. Sawhney, *A course in electrical & electronic measurement and instrumentation*, Dhanpat Rai & Sons, 2014.
2. S. Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, McGraw Hill, 2014.
3. R. B. Northrop, *Introduction to Instrumentation & Measurements*, CRC Press, 2005.
4. H. Zumbahlen, *Linear Circuit Design Handbook: Analog Devices*, Elsevier, 2008.

EE3104: POWER SYSTEM ANALYSIS [3 1 0 4]

Single line diagram, per unit concept, selection and change of base quantities, three winding transformer in power system, symmetrical short circuit current calculation, current limiting reactors, selection of circuit breakers, symmetrical components, sequence networks, unsymmetrical fault analysis in loaded and unloaded system involving transformers, admittance model of power system, load flow solution by numerical method, stability studies, equal area criterion.

References:

1. J. J. Grainger and W. D. Stevenson, *Elements of Power System Analysis* (4e), TMH, 2015.
2. D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis* (2e), TMH, 2013.
3. H. Saadat, *Power System Analysis* (3e), PSA Pub., 2010.
4. Elgerd Olle I., Electric Energy System Theory, TMH, 2011.

EE3130: DSP LAB [0 0 2 1]

Generation of waveforms, Sample and reconstruct analog signals, time and frequency response of LTI systems, Convolution, analysis of DTFT, DFT, Z transforms, pole zero diagrams, Spectrogram analysis of nonstationary signals, digital filter structures, Analysis of various classical discrete-time filters such as LP, HP, BP, BS, comb, notch, multi-notch, sinusoidal oscillators, all pass filters, FIR filter design, IIR filter design, simple applications of DSP in communication systems, speech processing, image processing, and electrical power.

References:

1. J.G. Proakis and D.G. Manolakis, *Introduction to Digital Signal Processing*, PHI, 2009.
2. A.V. Oppenheim and R.W. Schafer, *Discrete time signal processing*, Pearson, 2009.
3. S. K. Mitra, DSP: *A computer based approach* (2e), TMH, 2006.

EE3131: MEASUREMENTS & INSTRUMENTATION LAB [0 0 2 1]

Module 1: Familiarization of LabVIEW: Introduction to LabVIEW, Sub VI's and Loops, Case Structure, Express VI, Module 2: Measurement of physical signal like temperature, pressure, displacement. Measurement of electrical parameter, Power Measurement, Smart Metering, Signal conditioning: Realization of Instrumentation Amplifier, Realization of Analog Filter using TI ASLKv2010 Starter Kit, Module 3: Realization of a Digital Instrumentation System using PC: Realization of Digital spectrum analyser & digital voltmeter using LabVIEW.

References:

1. J. Jerome, *Virtual Instrumentation Using LabVIEW*, PHI Learning Pvt. Ltd., 2010.
2. K. R. K. Rao & C. P Ravikumar, *Analog system lab pro kit manual*, Mikro Elektronika Ltd. 2012.
3. J. Travis & J. Kring, *LabVIEW for Everyone: Graphical Programming Made Easy and Fun* (3e), Prentice Hall Professional, 2016.

EE3132: PROJECT BASED LEARNING LAB [0 0 2 1]

Project based learning aims to build students' creative capacity to work through difficult or complex problems. It encompasses student's involvement in designing, developing, and constructing hands-on solutions to a problem, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SIXTH SEMESTER

EE3201: LINEAR CONTROL THEORY [2 1 0 3]

Classification of control systems, Mathematical modelling of electrical circuits/mechanical systems (translational & rotary)/electro-mechanical systems/geared systems, reduction of sub-systems, signal flow graphs, Time domain response of 1st and 2nd order systems, RH criteria, Root Locus technique, Bode plots, Nyquist Plots, Frequency domain based compensator design and their realization through OPAMPS, Design/realization of active P, PI, PID controllers for LTI systems, State equation, state space modelling, Physical variable form State space models from transfer function, Solution of state equation for continuous time system, State transition matrix,

Controllability criteria, Observability criteria. Pole-Placement Design, Ackermann's Formula, State Estimation & Reduced-Ordered Estimators & Observers. MATLAB & SIMULINK for Linear Control Theory.

References:

1. Norman S. Nise, *Control Systems Engineering*, John Wiley & Sons, 2010.
2. K Ogata, Modern *Control Engineering*, Englewood Cliffs, NJ: Prentice Hall, 2010.
3. M. Gopal, *Control Systems: Principles and Design*, McGraw Hill, 2008.
4. B. C. Kuo, *Automatic Control Systems*, John Wiley & Sons, 2014.

EE3202: POWER ELECTRONICS [3 1 0 4]

Introduction to Power Electronics devices and protection: Thyristor family devices, principle of operation, IGBT operation, principles and ratings. Snubber designs, selection and protection, AC-DC converters: uncontrolled, semi-controlled, fully controlled and dual converters in single-phase and three-phase configurations, harmonic analysis, firing circuits and their designs. Choppers: Introduction to dc-dc conversion, buck, boost, buck-boost converters and Type E chopper. Inverters: Basics of dc to ac conversion, inverter circuit configurations and principle of operation, VSI and CSI, single and three-phase configurations, Square wave and sinusoidal PWM control methods and harmonic control. AC voltage controllers: Introduction to ac to ac conversion, single-phase and three-phase ac voltage controller circuit configurations, harmonic analysis, control, Cyclo-converters: single-phase to single-phase, three-phase to single-phase, three-phase to three-phase.

References:

1. D. W. Hart, *Introduction to Power Electronics*, PHI, 2010.
2. N. Mohan, T. M. Undeland, W. P. Robbins, *Power Electronics, Converters, Applications & Design* (2e), Wiley, 2001.
3. B. K. Bose, *Modern Power Electronics and AC Drives*, Pearson, 2002.
4. M. H. Rashid, *Power Electronics, Circuits, Devices and Applications*, PHI, 2010.
5. P. S. Bimbhra, *Power Electronics*, Khanna Publication, 2013

EE3203 SWITCH GEAR & PROTECTION [3 1 0 4]

Circuit breakers: Arc phenomenon, arc interruption theories, Current chopping, CB types: Oil circuit breakers, Air circuit breakers, SF6 CB, Vacuum CB, MCB, MCCB and HVDC circuit breakers. CB rating, testing, operating mechanism, Autoreclosure, Isolators and earthing switches, Fuses, low & medium voltage switchgear-layout, construction & mechanical interlocks, Gas Insulated Switchgear, Neutral grounding. Protective Relaying: Functions, characteristics, standard definition of relay terminologies, classifications & operating principles. Protection schemes for bus zone, transformer, alternator, transmission Line- Carrier Current Protection and Induction Motor. Introduction to Static Relays & Numerical relay.

References:

1. S. S. Rao, *Switchgear Protection and Power systems*, Khanna Publishers, 2015.
2. B. Ram and D. N. Vishwakarma, *Power System Protection & Switchgear*, MGH, 2014.
3. B. Ravindranath and M. Chander, *Power System Protection and Switchgear*, New Age International, 2018.
4. R. P. Singh, *Digital Power System Protection*, PHI, 2007.

EE3230: POWER ELECTRONICS LAB [0 0 2 1]

Power electronic devices – characteristics, AC-DC converters and its harmonic analysis, AC-AC converters, Speed control of DC motor, induction motor, Realization of DC to DC converter, Power electronic circuit simulation using MATLAB: AC to DC converter, DC to DC converter, DC to AC converter, AC to AC converter.

References:

1. D. W. Hart, *Power Electronics*, Tata Mcgraw-Hill, 2011.
2. N. Mohan, *Power Electronics, Converters, Applications & Design* (2e), Wiley, 2010.
3. B. K. Bose, *Modern Power Electronics and AC Drives*, Pearson, 2010.
4. A. S. Hadeed, *Simulation of Power Electronics Circuits using SIMULINK*, LAP LAMBERT Academic Publishing, 2014.

EE3231: POWER SYSTEMS LAB [0 0 2 1]

Module-I (Software based): YBUS and ZBUS formulation, Load flow study Newton-Raphson (N-R) and Fast Decoupled Load Flow (FDLF) Methods, Short Circuit Study, Contingency analysis, Optimal system operation & Unit Commitment, Transient stability analysis, Reactive power control and voltage stability, Simulations on MATLAB and DIgSILENT – Power Factory Software. Module-II (Hardware based): Over current protection using numerical relay- high set & low set protection, relay characteristics, over/under voltage protection, Motor protection feeder, Transformer protection, Generator protection, fault analysis: symmetrical and unsymmetrical faults, Transmission line performance evaluation, standalone and grid tied solar PV system.

References:

1. I. J. Nagrath and D. P. Kothari, *Modern Power System Analysis*, Tata Mc-Graw Hill, 2003
2. J. J. Grainger and W. D. Stevenson, *Elements of Power System Analysis* (4e), Tata McGraw Hill, 2003.
3. H. Saadat, *Power System Analysis*, McGraw Hill, 2011.
4. G. J. Duncan, *Power System: Analysis & Design*, Cengage Learning, 2012.

EE 3232: CONTROL & AUTOMATION LAB [0 0 2 1]

Basics of PLC and its Applications, Totally Integrated Automation, Human Machine Interface. Different applications of Home Automation, Industrial Automation. Real-time Production Line. Automation using Blockchain. Real-time Hardware Implementation & Hardware-In-Loop Simulation for different Control Applications with LabVIEW/MATLAB. Process Control Trainer Kits with DAQ Cards. Modeling & Simulation using MATLAB, Inverted Pendulum, PID Controller, Smart Systems, Internet-of-Things & Intelligent Systems.

References:

1. Frank D. Petruzella*, Programmable Logic Controllers* (4e), Mc Graw Hill Education, 2016.
2. John Essick, *Hands On Introduction to LabVIEW* (2e), Oxford, 2013.
3. Jerome Jovitha*, Virtual Instrumentation using LabVIEW* (2e), PHI, 2010.
4. D. K. Chaturvedi, *Modelling and Simulation of Systems Using MATLAB and Simulink*, CRC Press; 2010.

EE3270: MINOR PROJECT - I [0 0 2 1]

The project work may be carried out in institute laboratory. An interim project report on the progress of the work shall be submitted to the department during the mid-term evaluation. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, as part of project evaluation.

SEVENTH SEMESTER

EE4170: MINOR PROJECT - II [0 0 4 2]

The project work may be carried out in institute laboratory. An interim project report on the progress of the work shall be submitted to the department during the mid-term evaluation. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, as part of project evaluation.

EE4171: SEMINAR / INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a period of 4-6 weeks. This may be taken in a phased manner during the vacation starting from the end of sixth semester; the student has to submit to the department a training report in the prescribed format with a power point presentation followed by viva. The report should include the certificates issued by the industry.

EIGHT SEMESTER

EE4270: PROJECT WORK / PRACTICE SCHOOL - II

The project work may be carried out in an institution/ industry/ research laboratory. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the

project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, before the departmental committee, as part of project evaluation.

MINOR SPECIALIZATION

I. ELECTRIC VEHICLE TECHNOLOGIES

EE3254: DYNAMICS OF ELECTRIC VEHICLES [3 0 0 3]

Introduction: Classification, Analysis, Basic Components of Electric Vehicles, Electric Vehicle Modelling: General description of vehicle movement Rolling resistance, Aerodynamic drag, grading resistance, Acceleration resistance, Dynamic equation, Adhesion, Consideration of Vehicle Mass Dynamic wheel radius and slip, Electric Vehicle Vibration, Noise and Control, Braking Efficiency and Braking Distance. Power Train & its Performance: Introduction of Drive power train Configuration, Classification of Power Train, selection of a Power Train, operating performance, Economy, Environmental effects, Compare characteristic curves of different Power Train, Drive train tractive effort and vehicle speed, Maximum Cruising Speed, Acceleration Performance, Traction control system, Anti-lock Braking system, Hydraulic unit for ABS and EPS. Overview on effect of safety system on Dynamics of Vehicle. Modelling and simulation of Vehicle Dynamics.

References:

1. Reza N. Jazar, *Vehicle Dynamics: Theory and Application*, Springer, 2017.
2. R. Rajamani, *Vehicle Dynamics and Control*, Springer, 2011.
3. A. F. Andreev, V. Kabanau and V. Vantsevich *Driveline Systems of Ground Vehicles: Theory and design*, CRC Publishers 2010.

ELE 4159: DESIGN & MODELLING OF SPECIAL ELECTRICAL MACHINES [3 0 0 3]

Permanent Magnets Machines, Introduction to Inverters and Their Control. Dynamic Modelling of Permanent Magnet Synchronous Machine, Control Strategies for a Permanent Magnet Synchronous Machine, Flux-Weakening Operation, Design of Current and Speed Controllers, Parameter Sensitivity and Compensation, Rotor Position Estimation and Position Sensor less Control, PM Brushless DC Machine, Commutation Torque Ripple and Phase Advancing, Half-Wave PMBDCM Drives, Design of Current and Speed Controllers, Sensorless Control of PMBDCM Drive.

References:

1. R. Krishnan, *Permanent Magnet Synchronous and Brushless DC Motor Drives*, CRC Press, 2009.
2. Md. Enamul Haque, Permanent Magnet Synchronous Motor Drives: Analysis, *Modeling and Control*, VDM Verlag, 2009.
3. Chang-liang Xia, *Permanent Magnet Brushless DC Motor Drives and Controls*, Wiley, 2012.

EE4160: Electric Vehicle Power Converters & Drives [3 0 0 3]

Power Electronics & its Control Circuits: Basic Power Electronic Devices, EV configuration based on power converters, DC–DC Converter Topologies, Soft-Switching DC–DC Converter, Four Quadrants control strategy, PWM Switching Inverters, Voltage Source Inverters, Current Source Inverters, Control Techniques, bidirectional power flow converters controlling approach, Electric Drives in Electric Vehicles: Brushed-DC Electric Machine for Automotive Applications, Induction Motor Drives, Basics of speed control of Induction Motors, regenerative braking operation, different transient operation of the induction motor drives, soft starting, variable frequency drives, Fundamentals of Scalar and Vector control for Induction Motors, Brushless DC Drives, Sensorless Brushless DC Drives, Testing of Electric Motors and power electronics controllers for Electric vehicle, Modelling & Simulation using Matlab/Simulink: DC to DC converter controlled BLDC motor based vehicle system, Variable frequency control of Induction motor vehicle system and PWM Inverter with its control circuit.

References:

1. K. T. Chau, *Electric Vehicle Machines and Drives*, Design, Analysis and Application, John Wiley & Sons Singapore P. Ltd, 2015.
2. S. Soylu, Electric Vehicles –*Modelling and Simulations*, In Tech, 2011
3. P. Krause, O. Wasynczuk, S. Sudhoff and S. Pekarek, *Analysis of Electric Machinery and Drive Systems*, Third Edition, IEEE Press, 2015.

EE4161: Charging Technologies for Electric Vehicle [3 0 0 3]

Charging Protocols national & international standards. Architecture of the charging station. Key equipment's, Fundamental of rechargeable batteries and capacitors. Batteries management systems its performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of Charger, Conductive charging, Inductive Charging, Level 1,2 & 3 Charging Scheme, charging modes: Converter topologies, Charging methods- constant current (CC), constant voltage (CV), constant power (CP), taper charging, trickle charging, constant current/constant voltage (CC/CV). Fast charging strategies: Pulse-charging and negative pulse-charging of an EV battery. Effects of fast charging on battery life, Grid-to-Vehicle, Vehicle-to-Grid, Sharing Electric Charge Points and Parking Spaces, Electric Vehicle Solar Charging Stations. Impact of Plug-in Charging Current and Temperature on the Power Distribution System. Optimal design of electric vehicle charging station. Wireless Charging System Structure, Technologies & its Regulation: Wireless Power Transfer for Electric Vehicles, Architecture of the wireless charging station, key equipment's and technologies for Wireless charging, Selection of Optimum Frequency and Optimization, Optimum Design of Wireless Power Transfer System, The Economics of Wireless Charging on the Road, Regulatory and Safety Issues.

References:

1. I. S. Bayram and Ali Tajer, *Plug-In Electric Vehicle Grid Integration*, Artech House, 2017.
2. Quiwei Wu, *Grid Integration of Electric Vehicles in Open Electricity Market*, Wiley, 2013
3. S. Rajkaruna and F. Shahnia*, Plug In Electric Vehicles in Smart Grids*, Springer, 2015
4. S. Dhameja*, Electric Vehicle Battery Systems*, Newnes, 2001.

II RENEWABLE ENERGY SYSTEMS

EE3255: RENEWABLE ENERGY SOURCES [3 0 0 3]

Energy sources and their availability, Solar Energy - Solar radiation and measurements, solar energy storage, Solar Photo-Voltaic systems design- Wind Energy- Estimation, Maximum power and power coefficient, wind energy conversion systems, design considerations and applications. Energy from Bio-Mass- Sources of bio-mass, Biomass conversion technologies, Thermo-chemical conversion and Biochemical conversions, Anaerobic digestion and Fermentation, Bio-gas generation Pyrolysis and Liquefaction, Classification of Gasifiers, Geo-Thermal Energy, Energy plantation- Energy from the Oceans, Ocean Thermal Energy Conversion, Open and Closed Cycle plants, Site selection considerations, Origin of tides, Tidal energy conversion systems, Wave energy conversion systems, Hybrid Energy Systems.

References:

1. B. H. Khan, *Non-conventional Energy Resources*, TMH, 2009.
2. J. W. Twidell & A. D. Weir, *Renewable Energy Resources*, ELBS, 2005.
3. D. Mukherjee & S. Chakrabarti, *Fundamentals of Renewable Energy Systems*, New Age Intl., 2004.
4. G. D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers, 2004.

EE4162: SOLAR PHOTOVOLTAIC SYSTEMS [3 0 0 3]

Solar Radiation: Spectrum, Terminologies, Measurement, Estimation; Sun-Earth Movement & Angles, Sun Tracking, PN Junction Diode & Characteristics, Solar Cell, Photovoltage, Light Generated Current, I-V equation & Characteristics: Short Circuit Current, Open Circuit Voltage, Maximum Power Point, Fill Factor, Efficiency, Losses, Equivalent Circuit, Effect of Series & Shunt Resistance, Solar Radiation, Temperature on Efficiency, Solar PV Modules: Series & Parallel connection, Hotspots, Bypass & Blocking Diodes, Power Output, Ratings, I-V & Power Curve, Effect of Solar Irradiation & Temperature, Balance of System (BOS): Batteries: Classification, Capacity, Voltage, Depth of Discharge, Life Cycle, Factors affecting Battery Performance; Charge Controllers, DC to DC Converters, DC to AC converters, Maximum Power Point Tracking (MPPT).

References:

1. C. Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Application*, PHI New Delhi, 2009.
2. G. N. Tiwari, *Solar Energy: Fundamentals, Design, Modeling and Applications*, Narosa Publications New Delhi, 2013.
3. S. Deambi, *Photovoltaic System Design*, CRC Press USA, 2016.
4. F. Kreith and D. Y. Goswami, *Energy Management and Conservation Handbook* (2e), CRC Press USA, Fairmont Press, USA, 2017.
5. J. Balfour, M. Shaw and N. B. Nash, *Advanced Photovoltaic Installations*, Jones & Barlett Learning USA, 2013.

EE4163: WIND ENERGY CONVERSION SYSTEMS [3 0 0 3]

Wind Energy Basics: Status, Advantages and disadvantages of wind energy systems, Types of wind energy converters, local Effects on wind, site selection: roughness length, wind shear, Wind Speed Variability, Obstacles to wind flow, Working principles of wind energy: Energy content in wind, Energy Conversion at the Blade, Wind variations: Weibull distribution. Components of a wind energy converter: Rotor Blades, Gearboxes, Synchronous or Asynchronous Generators, Towers, Miscellaneous components, Turbine Selection Operation and Control of Wind Energy Converters: grid requirements, Issue of Noise and Its Control, Power Curve and Capacity Factor, Pitch control, Stall Control, Yaw Control.

References:

1. B. H. Khan, *Non-conventional Energy Resources*, TMH, 2006.
2. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, *Wind Energy Handbook*, John Wiley & Sons, (1e), 2001.
3. S. Mathew, Wind Energy, *Fundamentals, Resource Analysis and Economics*, Springer, 2006.
4. S. N. Bhadra, S Banerjee and D. Kastha, *'Wind Electrical Systems'*, Oxford University Press, (1e), 2005.

EE4164: DISTRIBUTED GENERATION SYSTEMS [3 0 0 3]

Introduction to Distributed Generation Systems- Principle and Structure of DGS- Features of DGS, Distributed Generation Technologies Overview, Integrating Distributed Energy Resources with the Grid, Planned/non-planned DG, Micro Grid and it's features. DG- Technologies: Wind Energy Conversion System, Photovoltaic Systems PV grid tied systems and different configurations. Micro turbine Generation, Small Hydro Generation Systems, Fuel Cells. Energy Storage Technologies-Different Energy storage technologies-Overview, Design Issues and control of Distributed Generation Systems-General model of DGS, Technical Regulation of DG integration, DG Optimization and Energy Management.

References:

1. G. B. Gharehpetian and S. Mohammad Mousavi Agah, *Distributed Generation Systems*: *Design, Operation and Grid Integration*, Butterworth-Heinemann, 2017.
2. Mahmoud, S. Magdi, AL-Sunni, and M. Fouad *Control and Optimization of Distributed Generation Systems*, Springer International Publishing, 2015.
3. Bo Zhao, C. Wang, and X. Zhang, *Grid Integrated and Standalone Photovoltaic Distributed Generation Systems Analysis, Design and Control*, Wiley, 2017.

III CONTROL SYSTEMS

EE3256: SYSTEM IDENTIFICATION [3 0 0 3]

Introduction to system modelling, Types of system models, Importance of system models, Model development techniques – first principle based and data driven based, Introduction to System Identification, Procedure for identification, Concept of Identifiability, Signal to Noise Ratio, Overfitting, LTI System Modelling using time and frequency, Direct impulse response identification, Direct step response identification, Impulse response Identification using step response, Empirical Transfer function Identification, Correlation Methods, Linear Regression, Least Square Estimation, Equation Error Models – ARX Models, ARMAX Models, ARIMAX Models, OE Models, Box Jenkins Model, Model Validation Techniques.

References:

1. A. K. Tangirala, *Principles of System Identification Theory and Practice*, CRC Press, 2016.
2. K. J. Keesman, *System Identification – An Introduction*, Springer, 2011.

3. L. Ljung, *System Identification: Theory for the User* (2e), Prentice Hall,1998.

EE4165: ROBUST CONTROL [3 0 0 3]

Introduction, Issues in Control System Design, Norms for signals and systems, Input- Output Relationships, Computing the Norm by State-Space Methods, Condition for Internal stability, sensitivity and complementary sensitivity function, Asymptotic Tracking, Performance, Sources of Model Uncertainties, Plant Uncertainty Model, Small Gain Theorem, Robust Stability, Robust Performance, Existence of Stabilizing Controllers, Parameterization of All Stabilizing Controllers, Coprime Factorization. Loop shaping with C, Shaping S, T, or Q, P-1 Stable, P-1 Unstable, The Modified Problem, Spectral Factorization, Case Studies-Robust Control for Mass Damper Spring Systems, Spacecraft and Inverted Pendulum.

References:

1. J. C. Doyle, B. A. Francis and A. Tannenbaum, *Feedback Control Theory*, Macmillan publishing co.,1990.
2. K. Zhou, J. C. Doyle and K. Glover, *Robust and Optimal Control*, Prentice Hall, Inc New Jersey.1995.
3. W. A. Wolovich, *Automatic Control Systems*, Saunders college publishing.1994.
4. K. Zhou and J. C Doyle, *Essential of Robust Control*, Prentice Hall Inc, New Jersey.1998.
5. R. C. Dorf and H. R. Bishop, *Modern Control Systems*, Addison Wesly Longman. Inc, 1998.

EE4166: NON-LINEAR CONTROL SYSTEM [3 0 0 3]

Introduction, Lyapunov stability using Krasovskii's method, Variable Gradient method, L2 stability of state models, L2 gain, small gain theorem, Passivity, Memory less functions, L2 gain and Lyapunov stability, passivity theorems, passivity based control, Review of describing function method, Absolute Stability Circle criterions, Popov Criterion, stabilization via linearization and Integral control, Gain scheduling, Graphical Linearization Methods, Analytical Linearization Method, Evaluation of Linearization Coefficients by Least-Squares Method, Local linearization, Feedback linearization, Input-state linearization, Input-output linearization, Internal dynamics, Zero dynamics, Model Reference Adaptive Control (MRAC). Sliding Mode Control, sliding surfaces, continuous approximations of switching control laws, modeling performance trade off, Tracking regulation via Integral control, Lyapunov redesign, non-linear damping, Back Stepping.

References:

1. H.K. Khalil, *Nonlinear Systems* (3e), Prentice Hall, 2002.
2. R. Marino and P. Tomei, *Nonlinear Control Design - Geometric, Adaptive and Robust*, Prentice Hall, 1995.
3. J.J.E. Slotine and W.Li, *Applied Nonlinear control*, Prentice Hall, 1998.
4. Alberto Isidori, *Non-linear Control Systems*, Springer Verlag, 1999.

EE4167: OPTIMAL CONTROL [3 0 0 3]

Foundation of Optimization Technique: Necessary and sufficient conditions for optima; convex analysis; unconstrained optimization; descent methods; Introduction to optimal control, Calculus of Variations and Optimal Control: Linear Quadratic Optimal Control Systems: Linear Quadratic Tracking System: Finite-Time and Infinite Time Case, Discrete-Time Optimal Control Systems: Variational Calculus for Discrete-Time Systems, Fixed-Final State and Open-Loop Optimal Control, Free-Final State and Open-Loop Optimal Control, Discrete-Time Linear State Regulator System, Kalman filter and duality, Steady-State Regulator System, Pontryagin Minimum Principle: The Hamilton-Jacobi-Bellman Equation, LQR System Using H-J-B Equation, Time Optimal Control System, Fuel-Optimal Control Systems. Game Theoretic Optimal Control Design

Reference:

1. D. E. Kirk., *Optimal Control Theory: An Introduction*, Dover publication, 2012.
2. D. G. Hull., *Optimal Control Theory for Applications*, Springer International, 2003.
3. B. D. O. Anderson and J. B. Moore, *Optimal Control: Linear Quadratic Methods*, Dover publication, 2007
4. D. S. Naidu., *Optimal Control Systems*, 1st ed., CRC Press., 2003.

IV POWER & ENERGY SYSTEMS

EE3257: COMPUTATIONAL TECHNIQUES IN POWER SYSTEM ANALYSIS [3 0 0 3]

Review of Power System Components: Network Matrices, Bus Impedance matrix, admittance matrix formation and modification of bus impedance matrix in three phase networks, Short Circuit Studies, symmetrical and asymmetrical faults: ZBUS and YBUS matrices for short circuit studies, short circuit calculations using ZBUS, symmetrical component analysis: calculation of currents and voltages, load Flow Studies: PQ, PV and slack buses, bus mismatch, Gauss-Seidal, Newton-Raphson and Fast Decoupled methods of load flow analysis, Stability Studies: Transient Stability, Swing equation, synchronous machine and induction machine equations, representation of load, modified Euler and Range-Kutta methods of transient stability analysis.

References:

1. M. A. Pai, *Computer Techniques in Power System Analysis*, (2e) Tata McGraw-Hill, New Delhi, 2005.
2. H. Saadat*, Power System Analysis*, TMH, 2004.
3. J. J. Grainger and W. D. Stevenson, *Elements of Power System Analysis* (4e), TMH, 2015.
4. E. V. Krishnamurthy and S. K. Sen, *Computer Based Numerical Algorithms*, East-West Press, New Delhi, 2008.

EE3258: POWER SYSTEM OPERATION & CONTROL [3 0 0 3]

Basic introduction to power system operations and control: The structure of modern electrical power system, Operating states of power system, Basic power system control and objectives - generating unit controls. Automatic Generation Control (AGC): Basic generator control loops, automatic load frequency control (ALFC), Mathematical modelling of turbine speed-governing system, steam turbine model and generator load model, complete block diagram representation, stead-state and dynamic analysis, Concept of control area- single and two area control, proportional-integral controller. Automatic Voltage Regulator (AVR): basic control loop, block diagram representation- exciter system, generator models, stability of excitation system. Reactive Power & Voltage Control: Necessity of voltage control, generation and absorption of reactive power, methods of reactive power/voltage control, reactive power flow and voltage collapse, concept of voltage stability, synchronous generator capability curve, reactive power compensation- series & shunt compensation. Economic Operations: Basics formulations of Economic Load Dispatch (ELD) and Unit Commitment (UC).

References:

1. P. Kundur*, Power System Stability Analysis & Control*, Tata Mc Graw Hill, 2006.
2. A. Wood & B. F. Woolenberg, *Power System Operation & Control*, John – Wiley, 2003.
3. S. Sivanagaraju & G. Sreenivasan, *Power System Operation and Control*, Pearson, 2013.
4. J. J. Grainger and W. D. Stevenson, *Elements of Power System Analysis* (4e), Tata McGraw Hill, 2003.
5. I. J. Nagrath & D. P. Kothari, *Modern Power System Analysis*, Tata Mc-Graw Hill, 2011.

EE4168: POWER SYSTEM RESTRUCTURING & DEREGULATION [3 0 0 3]

Introduction to Restructuring of Power Industry: Basic Terminology- Restructuring, Competition and Deregulation, Deregulation of power industry, Restructuring process, Issues involved in deregulation- Causes, Types and Effects of Restructuring, Deregulation of various power systems. Fundamentals of Economics: Consumer behaviour, Supplier behaviour, Market equilibrium, Short and long run costs, various costs of production, Types of Market Environments. Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity and other commodities, Market architecture, Role of the Independent System Operator (ISO), Operational planning activities of ISO- ISO in Pool markets, ISO in Bilateral markets, Transmission Congestion Management and Pricing: Power wheeling, Transmission open access, Transmission Pricing Schemes, Transmission Cost Allocation Methods of congestion management in deregulation. Ancillary Services Auction Market: General description of various ancillary services, ancillary services management in various countries, and reactive power management in the deregulated electricity markets.

References:

1. K. Bhattacharya, M. Bollen and J.C Daalder, *Operation of Restructured Power Systems*, Kluwer Academic Publishers, USA, 2001.
2. M. Shahidehpour, H. Yamin and Z. Li, *Market Operations in Electric Power Systems- Forecasting, Scheduling, and Risk Management*, John Wiley & Sons, Inc., New York; 2002.
3. D. Kirschen and G. Strbac, *Fundamentals of Power System economics*, John Wiley & Sons Ltd, 2004.
4. C. Harris, *Electricity Markets: Pricing, Structures and Economics*, John Wiley & Sons Ltd, 2006.

EE 4169 SMART GRID TECHNOLOGIES [3 0 0 3]

Smart Grid Overview- Smart Grid evolution, Definition of the Smart Grid, Key Characteristics of Smart Grid, Key Functions of a Smart Grid, Smart Grid Elements. Traditional Electric Grid Model, Generation, Transmission, Distribution, Energy Storage, Micro-grids, Integration of new technologies into the grid, Smart Grid vision and its realization in Urban/Rural, Smart Grid infrastructure, Functionality, Reliability, Cost/Tariff, Standards, Smart Grid cyber security, Smart Grid Operations- Electric Grid (power delivery), SCADA (supervisory control and data acquisition), Smart Grid Control Layer-fault detection and location, Data collection and management, Control Layer Infrastructure, Software-Define Networks (SDN), Control Algorithms, Volt-VAR control, Distribution automation, Grid storage systems, Intermittent renewable, Cooperative grids.

References:

1. J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, IEEE press, John Wiley & Sons, 2012.
2. T. Sato, Daniel M. Kammen, B. Duan, M. Macuha, Z. Zhou, and Jun Wu, *Smart Grid Standards: Specifications, Requirements, and Technologies*, Wiley-Blackwell, 2015.
3. J. Ekanayake, K. Liyanage, Jianzhong Wu, A. Yokoyama, and N. Jenkins, *Smart Grid: Technology and Applications*, Wiley, New Delhi, 2015.
4. L. T. Berger and K. Iniewski, *Smart Grid Applications, Communications, and Security*, Wiley, New Delhi, 2015.
5. K. Salman, *Introduction to the Smart Grid: Concepts, Technologies and Evolution*, The Institution of Engineering and Technology, United Kingdom, 2017.

PROGRAMME ELECTIVES

EE3240: DATA STRUCTURES & ALGORITHMS [3 0 0 3]

Pseudo-code, algorithm analysis, asymptotic notations, iterative and recursive algorithms. Data Structures, data structure operations, review of arrays, structures, Stacks and Queues, stack and queue operations, array representation of stacks and queues, queues and stacks using linked lists, applications of queues and stacks. Properties of Binary search trees, array and linked list representation of binary search trees, binary search tree traversals. Graphs and their representations, application of graphs. Searching and sorting methods. Algorithm design techniques – Greedy, Divide and Conquer, Dynamic programming and Backtracking. Addressing limitations of algorithmic power - P, NP, and NP-Complete Problems.

References:

1. Cormen, Leiserson and Rivest, *Introduction to algorithms*, (3e), MGH, 2009.
2. Aho, Hopcroft and Ulmann, *Design and Analysis of Algorithms*, (1e), Pearson 2002.
3. Aho, Hopcroft and Ulmann, *Data Structures & Algorithms*, (1e), Pearson 2002.
4. Horowitz and Sahni, *Fundamentals of computer algorithms*, (1e), Universities Press. 2008.
5. S. Lipschutz, *Data Structures with C*, Schaum's ouTlines, McGraw Hill Education, 2011

EE3241: DATABASE MANAGEMENT SYSTEMS [3 0 0 3]

Data-base system applications, Data models, schemas and instances. Three-schema architecture and data independence. Entity-Relationship Model: Entity, Attribute, Constraints. Relational model Concepts, Relational algebra: SELECT, PROJECT and DIVISION. Relational database design using ER-to-Relational Mapping. Structured Query Language (SQL), Queries in SQL. Query processing and optimisation, Database design: Functional dependencies, normalisation. Transaction management: ACID properties, concurrency control, transactions and scheduling, locking. Data warehousing, datamining and data analytics. Applications and case studies.

References:

1. AviSilberschatz, Henry F. Korth, S. Sudarshan, *Database System Concepts* (6e), McGraw-Hill, 2016.
2. Ramez Elmasri, Shamkant B. Navathe, *Fundamentals of Database Systems* (7e), Pearson, 2016.

EE3242: OBJECT ORIENTED PROGRAMMING [3 0 0 3]

Introduction to fundamental concepts of programming language, Object Oriented Programming paradigm, Characteristics of object oriented languages. Classes and Objects: Class specification, Class objects, Accessing Class Members, Static members, Constructors and Destructors, Parameterized constructors, Multiple Constructors, Friend function. Operator Overloading & Type conversion: Defining operator overloading, Overloading Unary and Binary operators, Overloading using friend function, Type conversion: Basics to class type,

class to basic type and class to another class type. Inheritance: Derived class and base class, Types of inheritance, Levels of Inheritance, Single inheritance, Multiple Inheritance, Hierarchical inheritance and Hybrid inheritance. Polymorphism: Virtual Functions: Pure function, Friend classes. Files and Exception Handling: Classes for file stream operation, Opening and closing a file, file modes, file pointers and manipulators. Exception handling mechanism: throwing, catching all the exceptions.

References:

1. J. Rumbaugh et. al, "Object Oriented Modeling and Design", PHI, 2004
2. E. Balagurusamy, "*Object Oriented Programming with C++*", (6e), Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2013.
3. R. Lafore, "*Object Oriented Programming in Turbo C++*", (3e), Galgotia Publications Pvt. Ltd., New Delhi, 2006
4. S. B. Lippman, Josee Lajoie, Barbara E Moo, "*C++ Primer*",(5e), Addison-Wesley Professional, 2012
5. H. Schildt, "*The Complete Reference C++*", (4e), TMH, New Delhi, 2004

EE3243: ARTIFICIAL INTELLIGENCE [3 0 0 3]

Foundation and History of AI, State of the art, Fields of application , Performance measures, Rationality, Specification and properties of task environment, Structure of Agents, Problem solving by searching, Searching for solutions, uninformed search strategies, Informed search strategies, Heuristic functions, Local search algorithms, Online search agents, Knowledge based agents, The Wumpus World, Propositional logic – reasoning patterns, effective inference, First order logic - Syntax and semantics, Knowledge engineering, Inference rule, forward and backward chaining, Ontological engineering, categories and objects, Processes and intervals, reasoning systems, Truth maintenance systems, Uncertainty, Basic probability notation, Axioms, Baye's rule, Bayesian networks, Inference in Bayesian networks.

References:

1. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach* (3e), Pearson, 2012.
2. E. Rich, K. Knight and Shivashankar B. Nair, *Artificial Intelligence* (3e), Tata McGraw Hill, 2012.
3. D. Poole and A. Mackworth, *Artificial Intelligence: Foundations of Computational Agents* (2e), Cambridge University Press, 2017

EE3244: SOFT COMPUTING TECHNIQUES [3 0 0 3]

Introduction to Soft computing, soft computing techniques, Artificial Neural Networks, Multilayer Perceptron, Gradient descent, Logistic discrimination, Single layer Perceptron, Training a perceptron, Multilayer perceptron, Back-Propagation Algorithm, Fuzzy Systems, Fuzzy Logic, Membership Functions, Fuzzy Controllers, Evolutionary Algorithms, Genetic Algorithms, Other Optimization Techniques, Metaheuristic Search, Traveling Salesman Problem, Introduction to hybrid systems, Adaptive Neuro-Fuzzy Inference Systems, Evolutionary Neural Networks, Evolving Fuzzy Logic, Fuzzy Artificial Neural Networks.

References:

1. J. M Zurada, *Introduction to Artificial Neural Systems*, Jaico publication. 2016
2. T. J. Ross, *Fuzzy Logic with Engineering Applications*, (Intl. e), McGraw Hill publication, 2012.
3. S. Haykin, *Neural Networks and Learning Machines*, PHI, 2008
4. Shivanandam & Deepa, *Principles of Soft Computing*, Wiley India edition, 2009.
5. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms*, PHI Learning,2003

EE3245: COMPUTER NETWORKS [3 0 0 3]

Introduction to computer networks and Internet, network edge and core, delay and throughput in packet switched networks, Protocol layers and their service models. Session, Presentation, and Application Layers. Examples: DNS, SMTP, FTP, HTTP. Transport layer: UDP, TCP. Connection establishment and termination, flow and congestion control, timers. Network layer: Internet Protocol, IPv4, IPv6, ICMP, Network Address Translation. Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Link Layer: Error detection (Parity checks and CRC), Multiple Access Protocols - ALOHA, CSMA. Switched LANs addressing, ARP, Ethernet-Gigabit Ethernet, VLANs. Datacentre networking. Wireless LANs-Wi-Fi (802.11). Multimedia Networking - UDP and HTTP streaming, Voice-over-IP, Case studies- Skype, YouTube, Case study on Webpage request, Overview of Software

defined Networks (SDN)

References:

1. A. S. Tanenbaum, DJ Wetherall, *Computer Networks* (5e), Prentice Hall, 2010.
2. L. L. Peterson, BS Davie, *Computer Networks: A Systems Approach* (5e), Morgan-Kauffman, 2011.
3. J. F. Kurose and K. W. Ross, *Computer Networking: A Top-Down Approach* (5e), Addison-Wesley, 2009.
4. W. Stallings, *Cryptography and Network Security, Principles and Practice* (5e), Prentice-Hall, 2010.

EE3246: UTILIZATION OF ELECTRIC POWER [3 0 0 3]

Electric Drives: Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, Particular applications of electric drives, Types of industrial loads, continuous, Intermittent and variable loads, load Equalization. Electric Heating: Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating. Electric Welding: Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding. Electric Traction: System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging, rheostatic braking and regenerative braking, Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves. Calculations of tractive effort, Illuminations.

References:

1. C. L. Wadhwa, *Generation, Distribution and Utilization of electrical Energy* (3e), New Age International (P) Limited Publishers, 2010.
2. N. V. Surya Narayana, *Utilization of Electrical Power including Electric drives and Electric traction* (1e), New Age International Publishers, 1996.
3. A. K. Sawhney, *A course in Electronic Measurements and Instrumentation*, Dhanpat Rai & Co., 2015
4. H. Partab, *Modern Electric Traction*, Dhanpat Rai & Co., 2017

EE3247: INTRODUCTION TO ELECTRIC VEHICLE [3 0 0 3]

History of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, comparison between IC engine and Electric vehicle. Electric Vehicle: Configuration of Electric Vehicle, Electric Propulsion Unit- DC machines (BLDC & BDC), three phase A/c machines, Induction machines, switched reluctance machines. Power Convertor- DC to DC, DC to AC and AC to DC Convertors. Electric Vehicle Drive Train - Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing. Sizing the drive system: Sizing the propulsion motor, power electronics, Energy Source System- Types of batteries, Parameters – Capacity, C-rate, SOC, DOD. Technical characteristics of Lithium Ion and Lead-Acid batteries. Battery pack Design, Thermal issues in batteries, Fuel Cell based energy storage, Super Capacitor based energy storage and Flywheel based energy storage and analysis. Battery Management System- functions and Topology. Hybrid Electric Vehicles: Hybrid Types – series, parallel and mild parallel configuration.

References:

1. I. Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. M. Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2004.
3. J. Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.

EE3248: SEMICONDUCTOR DEVICE THEORY [3 0 0 3]

Energy Bands in Solids, Electron and Hole Densities in Equilibrium, Excess carriers—Non-equilibrium Situation, Junctions and Interfaces, Charge Transport in Semiconductors, P-N Junctions and its applications. Junction Field Effect Transistor and Metal-Semiconductor, MIS Junction/capacitor - ideal C-V characteristics and deviations due to interface states/charges and work function differences, threshold voltage. Field Effect Transistor, MOSFETs-operation and characteristics.

References:

1. M. K. Achuthan and K. N. Bhat, *Fundamentals of Semiconductor Devices*, Tata McGraw Hill, New Delhi, 2011.
2. B. G. Streetman and S. Banerjee, *Solid State Electronic Devices*, PHI, New Delhi, 2011.
3. N. D. Gupta and A. D. Gupta, *Semiconductor Devices. Modelling and Technology*, PHI, New Delhi, 2004.

EE3249: DIGITAL SYSTEM DESIGN USING HDL [3 0 0 3]

Digital implementation options, Digital system modeling: Domains, levels of abstraction. Introduction to Verilog AND VHDL: Behavioral, data-flow and Gate level modeling. Design case studies - combinational, sequential, FSM, Test Benches. Verilog HDL Synthesis, Interfacing Applications, Programmable ASICs, Programming Technologies.

References:

1. M. J. S. Smith, *Application Specific ICs*, Pearson, 2010.
2. S. Palnitkar, *Verilog HDL: A Guide to Digital design and Synthesis*, PHI, 2003.
3. S. Brown and Z. Vranesic, *Fundamentals of Digital Logic with Verilog*, Design, TMH 2013.
4. N. M. Botros, HDL Programming: VHDL and Verilog, Dreamtech, Press, 2009.

EE3250: DIGITAL IMAGE PROCESSING [3 0 0 3]

Introduction, components of image processing system, Spatial domain transformations, histogram processing, smoothing, sharpening spatial filters, Filtering in the frequency domain- Introduction to Fourier transform, image smoothing, image sharpening using frequency domain filters. Image restoration-Noise models, restoration using spatial filtering, periodic noise reduction by frequency domain filtering, Morphological image processing-Preliminaries, dilation and erosion, opening and closing, hit-or-miss transformation, basic algorithms, extension to gray-scale images, Image segmentation- Point, line, and edge detection, Thresholding, Region Segmentation Using Clustering and Superpixels, Graph Cuts, morphological watersheds, motion in segmentation.

References:

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, (4e), Pearson, 2017.
2. M. Sonka, V. Hlavac and R. Boyle, Image Processing, Analysis and Machine Vision, (4e), CENGAGE Learning, 2014
3. R. C. Gonzalez, R. E. Woods and S. L. Eddins, Digital Image Processing Using MATLAB, (2e), Mc Graw Hill India, 2010
4. G. B. García, O. D. Suarez, José Luis Espinosa Aranda, J. S. Tercero, I. S. Gracia, and N. V. Enano, Learning Image Processing with OpenCV, (1e), Packt Publishing, 2015

EE3251: SPECIAL ELECTRICAL MACHINES [3 0 0 3]

Stepping motors :Constructional features , Principle of operation ,Variable reluctance motor, Hybrid motor , Single and multi-stack configurations ,Torque equations ,Modes of excitations, Characteristics , Drive circuits, Microprocessor control of stepping motors, Closed loop control. Switched reluctance motors : Constructional features , Rotary and Linear SRMs ,Principle of operation, Torque production ,Steady state performance prediction, Analytical method ,Power Converters and their controllers, Methods of Rotor position sensing, Sensor less operation, Closed loop control of SRM, Characteristics. Permanent magnet brushless D. C. motors: Permanent Magnet materials, Magnetic Characteristics, Permeance coefficient, Principle of operation, Types, Magnetic circuit analysis, EMF and torque equations, Commutation, Power controllers, Motor characteristics and control. Linear induction motor, Repulsion motor, Hysteresis motor, AC series motor, Servo motors.

References:

1. R. Krishnan, Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application, (2e), CRC Press, New York, 2001.
2. P. P. Aearnley, Stepping Motors – A Guide to Motor Theory and Practice, (2e), Peter Perengrinus, London, 2004.
3. T. Kenjo and S. Nagamori, Permanent Magnet and Brushless DC Motors, (2e), Clarendon Press, London, 2006
4. T. J. E. Miller, Brushless Permanent Magnet and Reluctance Motor Drives, (2e), Clarendon Press, Oxford, 2003.
5. T. Kenjo, Stepping Motors and Their Microprocessor Control, (2e), Clarendon Press London, 2002

EE3252: HIGH VOLTAGE ENGINEERING [3 0 0 3]

Generation and transmission of electric energy, Voltage Stresses, Testing voltages. Generation of High D.C.&A.C, Voltages and Currents, and Impulse currents & voltages: Half-wave rectifier circuit, Voltage doubler circuits, Cockroft-Walton Voltage multiplier circuit, Electrostatic Generator, Vande-Graff Generator, Cascaded Transformers, Impulse voltage Generator, Marx's multi stage voltage generator, Generation of switching surges,

Measurement: High Voltage DC, AC and Impulse Currents & Voltages, Over view of the Breakdowns, Electrical Field distribution and stress control, Breakdown in gases, solid and liquid dielectrics, Corona discharges, Partial-discharge.

References:

1. M. S.Naidu, V. Kamaraju, *High Voltage Engineering* (3e), Tata McGraw Hill-2004.
2. C. L. Wadhwa*, High Voltage Engineering* (2e), New Age International-2007.
3. Zangel & Kuffel, *High Voltage Engineering* (2e), Newnes-2000.

EE3253: POWER SYSTEM ENGINEERING [3 0 0 3]

Economic Operation of Power Systems: Introduction, system constraints, optimal operation of power systems. Input output, heat rate and incremental rate curves of thermal generating units. Economic distribution of load between generating units within a plant. Economic distribution of load between power stations, transmission loss equation. Introduction to unit commitment and dynamic programming. Power System Stability-I: Power angle equations and power angle curves under steady state and transient conditions. Power System Stability-II: Introduction to transient stability. Equal area criterion and its application to transient stability studies under basic disturbances. Critical clearing angle and critical clearing time. Factors affecting stability and methods to improve stability. Excitation Systems: Introduction of excitation systems of synchronous machines, types of excitation systems, Elements of various excitation systems and their control (functional block diagrams and their brief description)-DC excitation systems, AC excitation systems, brushless excitation system. Interconnected Power Systems: Introduction to isolated and interconnected powers systems. Reserve capacity of power stations, spinning and maintenance resaves. Advantages and problems of interconnected power systems.

References:

1. I. J. Nagrath and D.P. Kothari, *Power System Engineering* (2e), MGH. 2011
2. J. J. Grainger and W. D. Stevenson, *Power System Analysis*, MGH. 2003
3. W. D. Stevenson, *Element of Power System Analysis*, MGH. 1982.
4. B. R. Gupta, *Power System Analysis and Design* (3e), S. Chand & Co. 2008.
5. C. L. Wadhwa, *Electrical Power Systems* (3e), New age international Ltd., 2009.

EE4140: INTERNET OF THINGS [3 0 0 3]

Introduction to Internet of Things, Sensing, actuation, Basics of Networking, Sensor networks, Machine to Machine communication (M2M), IOT technologies and Architectures: Infrastructure and service discovery protocols for the IoT ecosystems; Realization of IoT ecosystem using wireless technologies; Interoperability in IoT, Data handling and analytics, cloud computing, Real world design constraints, IoT use Cases.

References:

1. P. Raj and A. C. Raman, *The Internet of Things: Enabling Technologies, Platforms & Use Cases*, CRC Press, 2017.
2. A. Bahga and Vijay Medisetti, *Internet of Things: A Hands-on Approach*, University Press, 2014
3. J. Holler, V. T Siatsis, C. Mulligan, S. Karnouskos, S. Avesand and D. Boyle, *From Machine to Machine to the Internet of Things: Introduction to a New Age of Intelligence*, Academic Press, 2014.
4. F. Vahid and Givargis *Embedded Systems Design: A Unified Hardware/Software Introduction*, Wiley Publications, 2000.

EE4141: BLOCKCHAIN TECHNOLOGY [3 0 0 3]

Blockchain Concepts: Evolution, Structure, Characteristics, Stack, Benefits & Challenges, Domain Specific Applications, Design Methodology for Applications; Smart Contracts: Structure, Compiling & Deploying a Contract, Transactions and Calls, Interacting with a Contract, Gas, Examples, Smart Contract Patterns; Mining: Consensus on Blockchain Network, Different Stages, Block Validation, Setting up Node; Whisper Protocol; Advanced Topics on Blockchain: Double-Spending Problem, Byzantine Fault Tolerance, Proof-of-Work vs Proof-of-Stake, CAP, GHOST, Sybil Attack, Mining Pools & Centralization, Smart Contracts Vulnerabilities, Blockchain Scalability; Understanding Decentralized Applications & How Ethereum Works.

References:

1. M. Swan, *Blockchain Blueprint for a New Economy*, O'Reilly Media, 2015.
2. A. Bahga and V. Madisetti, *Blockchain Applications: A Hands-On Approach*, A. Bahga & V. Madisetti, 2017.

3. N. Prusty, *Building Blockchain Projects*, Packt, 2017.

EE4142: MACHINE LEARNING [3 0 0 3]

Machine learning basics, Naïve Bayesian Model. Non-Parametric Techniques: Density Estimation, Parzen Windows, k- Nearest-Neighbour Estimation, K- nearest neighbour classification, Radial Basis Function Network, Learning Vector Quantization, Clustering, K-Means clustering, Competitive learning, Self-Organizing Maps, Recurrent Neural Network, Hopfield Neural Network, Adaptive Resonance Theory, Support vector machines, Statistical Hypothesis testing- t-test, ANOVA, feature selection methods – Filter based techniques and wrapper methods, Principal Component Analysis, Applications of PCA, PCA ,Independent component analysis, Voting, Error correcting output codes, Bagging, Boosting.

References:

1. E. Alpaydin, *Introduction to Machine Learning*, (2e), MIT Press. 2010.
2. R. O. Duda, Peter E. Hart, David G. Stork, *Pattern Classification*, (2e), Wiley, 2001.
3. P. Harrington, *Machine Learning in Action*, Manning Publications, 2012.
4. C. M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.
5. R. Jensen, Qiang, Shen *Computational Intelligence and Feature Selection: Rough and Fuzzy Approaches*, Vol. 8, IEEE Press Series on Computational Intelligence, John Wiley & Sons, 2008.

EE4143: DATA ANALYTICS [3 0 0 3]

Introduction to Data science, Data analytics. Similarity, sequencing, sampling and quantization. Data Pre-processing, Error types, Error handling, Filtering, Data transformation and Data integrations. Modelling with data and Data visualizations. Correlation and causality tests. Regression analysis, Forecasting, Classification and clustering techniques. Introduction to Python-programming for data analytics.

References:

1. T. A. Runkler, *Data Analytics Models and Algorithms for Intelligent Data Analysis* (2e) Springer Publications, 2016.
2. S. A. Pardo, *Empirical Modeling and Data Analysis for Engineers and Applied Scientists*, Springer International Publishing, 2016.
3. W. L. Woon, Z. Aung, O. Kramer, S. Madnick, *Data Analytics for Renewable Energy Integration*, Springer 2017.
4. R. I. Kabacoff, *R in action: Data analysis and graphics with R*, Manning Publications C, 2011

EE4144: MODERN OPTIMIZATION TECHNIQUES [3 0 03]

Intoduction to optimization problems, Tradional Methods: Linear programming, Newton's Method, Interior point method, Nonlinear programming, Quadratic Programming, Modern Techniques: Genetic Algorithm, Simulated Annealing algorithm, Particle Swarm Optimization, Tabu search method, Differential Evolution, Introduction to multi-objective optimization problem.

References:

1. K. Deb, Optimization for Engineering Design: Algorithms and Examples, PHI, 2012.
2. A. Ravindran, K. M. Ragsdell and G. V. Reklaitis, Engineering Optimization: Methods and Applications (2e), John Wiley & Sons, Inc., 2006.
3. K. Y. Lee and M. A. El-Sharkawi, Modern Heuristic Optimization Technique: Theory and Applications to Power Systems, IEEE Press, 2008.

EE4145: CONTROL SYSTEM DESIGN [3 0 0 3]

Control System performance objectives, Design of cascade & feedback compensation, Scalar and multivariable control systems, Industrial PID controllers, Continuous & Discrete PID control, PID tuning, Dead Beat Algorithm. Adaptive Control: Self tuning control; Model Reference Adaptive Control; High gain observers; Practical aspects. Digital Control Systems: Introduction, Sampling, Data acquisition, Quantization, sample and hold, zero order hold, frequency domain consideration in sampling and reconstruction. Difference equations, pulse transfer function, Block diagram analysis of sample data systems, time response of discrete time control systems, Steady State error analysis, Stability, Jury's stability test, bilinear transformation, Root locus technique, W transformation, Bode Plot. Nyquist Stability analysis, Design of Lag, Lead, Lag-lead compensator using Root Locus & Bode plot. Control

System Design Examples; MATLAB & SIMULINK for Control System Design.

References:

1. S. M. Shinners, *Advanced Modern Control System Theory and Design*, John Wiley & Sons, 1998.
2. M. A. Johnson and M. M. Moradi, *PID Control: New Identification and Design Methods*, Springer 2005.
3. K. Ogata, *Discrete Time Control Systems* (7e), PHI 2011.
4. G. F. Franklin, J. D. Powell, M. L. Workman, *Digital Control of Dynamic Systems* (2e), A-Wesley Publishing Company, 1997.

EE4146: ROBOTICS AND AUTOMATION [3 0 0 3]

Basic Concepts: Definition and origin of robotics, different types of robotics various generations of robots, degrees of freedom, Asimov's laws of robotics, dynamic stabilization of robots. Power Sources and Sensors: Hydraulic, pneumatic and electric drives, variable speed arrangements, path determination, micro machines in robotics, machine vision, ranging laser, acoustic, magnetic, fiber optic and tactile sensors. Manipulators, Actuators and Grippers. Kinematics and Path Planning: Solution of inverse kinematics problem, multiple solution Jacobian work envelop, hill climbing techniques, robot programming languages. Case Studies: Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot.

References:

1. N Odrey, M. Weiss, M. Groover, R. Nagal and A Dutta*, Industrial Robotics- SIE: Technology-Programming and Applications*, McGraw-Hill Education, 2017.
2. B. K. Ghosh, T. J. Tarn and N Xi, *Control in Robotics and Automation: Sensor-Based Integration*, Academic Press, 2011
3. S. R. Deb and S. Deb, *Robotics technology and flexible Automation*, McGraw-Hill Education, 2017
4. N. S. Nise, *Control Systems Engineering* (5e), John Wiley & Sons Inc, 2010

EE4147: INDUSTRIAL AUTOMATION & CONTROL [3 0 0 3]

Data loggers, Data Acquisition Systems, Direct Digital Control, SCADA, Programmable Logic Controller, Ladder logic Programming, PID functions, analog PLC operation, Alternate Programming Languages, PLC Maintenance, Interface and Backplane Bus Standards, Field bus, HART protocol, Smart transmitters, Valves and Smart actuators, MODBUS, Profibus, IEC 1158-2 Transmission Technology, Distributed Control Systems, Local Control Unit, Communications for DCS, Displays - Engineering interfaces. Control Technologies in Automation: Industrial Control Systems Continuous Versus Discrete Control, Computer Process. Computer-Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems Distributed Control System. Modelling and Simulation for Plant Automation need for system Modelling Modern Tools & Future Perspective. HMI Design.

References:

1. J. W. Webb and R. A. Reis, *Programmable Logic Controllers - Principles and Applications*, PHI, (4e). 2002.
2. M. P. Lukcas, *Distributed Control Systems*, Van Nostrand Reinhold Co., 1986.
3. F. D. Petruzella, *Programmable Logic Controllers*, MGH, (2e), 2016.

EE4148: MODERN DC-DC POWER CONVERTER [3 0 0 3]

Switched Mode Power converters: generalized comparison between switched mode and linear regulators, operation and steady state performance of buck, boost, buck-boost, Cuk, SEPIC ZETA: continuous conduction mode, discontinuous conduction mode; Performance analysis of converters using DC Transformer model; DC-DC converters with isolation- Fly back converter, Forward converter, push-pull converter, half bridge and full bridge DC-DC converters; Resonant Converters- series and parallel loaded converters in continuous and discontinuous mode of operation, zero current switch resonant converter (ZCS), zero voltage switch resonant converter (ZVS); Control techniques- Voltage feed forward PWM control, current mode control, digital pulse width modulation control; Converter modelling- equivalent circuit modelling of converters using state space averaging technique; Closed loop converter design – PID design issues; Electromagnetic interference – input filter design and its effect on converter performance.

References:

1. R. W. Erickson, Dragan Maksimovic, *Fundamentals of Power Electronics* (2e), Springer, 2005.

2. D. W. Hart, *Introduction to Power Electronics*, PH, 2010.
3. N. Mohan et. al., *Power Electronics, Converters, Applications & Design* (2e), Wiley, 2001.

EE4149: ADVANCE POWER CONVERTER DESIGN [3 0 0 3]

Multilevel Inverters: - Multi-level inverters, advantages, configurations: Diode clamped, flying capacitor and cascade multi-level inverters, applications, Selective harmonics elimination technique (SHE), Application of SHE in symmetric and asymmetric multilevel inverter, evolution of multilevel inverter topologies, new upcoming multilevel inverter topologies. Advance Power electronics Converters for Wireless Power Transfer:-Introduction to wireless power transfer using power electronics converters, Wireless power transfer for vehicular applications, static and dynamic charging, inductive power transfer for static charging of electric vehicle, Series-Series (SS), Series-Parallel (SP), Parallel-Series (PS), Parallel-Parallel (PP) topologies for inductive power transfer charging of electric vehicle, derivation of efficiency, Derivation of design parameters for SS topology, Society of Automotive Engineers (SAEJ2954) standards for wireless power charging of Electric Vehicle. Case study for designing IPT based IPT charging.

References:

1. C. T. Rim and C. Mi, *Wireless power transfer for electric vehicles and mobile devices*, John Wiley & Sons; 2017.
2. K. K. Gupta and P. Bhatnagar, *Multilevel Inverters: Conventional and Emerging Topologies and Their Control,* Academic Press; 2017.

EE4150: MICROCONTROLLER IN POWER ELECTRONICS [3 0 0 3]

Evolution of micro-controllers: comparison between microprocessor and micro controllers, Microcontroller development systems: 8051, 8096 and PIC Series Microcontrollers, architecture, hardware description, Addressing modes, Terminology, Linear addressing, segmented addressing and stack addressing, Instruction set, arithmetic operations, logical operations, data transfer operations, control transfer operations, Interrupt structure and Timers, Assembly language programming: C program structure, data acquisition, Typical applications in the control of power electronic converters for power supplies and electric motor drives.

References:

1. D. V. Hall, *Microprocessors and Interfacing - Programming and Hardware* (11e), Tata McGraw- Hill, 2017.
2. K. J. Hintz and D. Tabak, *Microcontrollers - Architecture, Implementation and programming*, McGraw Hill, USA, 2005.
3. J. B. Peatman, *Design with microcontrollers*, McGraw Hill International Ltd, 2002.

EE4151: SOLID STATE DRIVE [3 0 0 3]

Fundamentals of Electric Drives: components, dynamics, multi-quadrant operation, equivalent moment of inertia and torque, nature and classification of load torque, steady state stability; classes of motor duty. DC Drives: single phase and three phase controlled rectifier fed dc drives controlled freewheeling, speed torque characteristics, waveforms, expressions for voltage, current, speed, torque and power. Chopper fed DC drives- quadrants of operation; AC drives: Induction Motor Drives stator voltage control, rotor resistance control, slip power recovery scheme, frequency control-control strategies, DQ model, principle vector control, direct and indirect vector control scheme; Synchronous Motor Drives- overview of scalar and vector control schemes of PMSM and BLDC motors, brushless DC excitation.

References:

1. G. K. Dubey, *Power Semiconductor Controlled Drives*, PHI, 1989.
2. G. K. Dubey, *Fundamentals of Electric Drives*, Narosa, 2010.
3. J. M. D. Murphy & F.G. Turnbull, *Power Electronic Control of AC motors*, Pergamon 1989.
4. B. K. Bose, *Modern Power Electronics and AC Drives*, Pearson, 2010.
5. R. Krishnan, *Electric Motor Drives: Modeling, Analysis, and Control*, Pearson, 2011

EE4152: SOLID STATE TRANSFORMER [3 0 0 3]

Solid- State Devices: Review of SCR, Driving circuits and protection, Modern semiconductor devices, MOSFET, GTO, IGBT, SIT, SITH, MCT, Their operating characteristics, Heat sink design. AC-AC Converters: Three-phase ac regulators, Operation with resistive load, Single phase and three phase cyclo-converters, Matrix converters,

output voltage control techniques, Commutation methods. Multilevel Inverters: Review of three-phase voltage source inverters, Voltage and frequency control, Harmonic reduction techniques, PWM inverters, Space vector Modulation, Multilevel Inverters, Configuration: Diode clamped, Flying capacitor and cascaded multi-level inverters, application, Current source inverter, Commutation circuits, Transient voltage suppressing techniques, DC link resonant converters, Operation and control, Single-phase Transformer: Principle of operation, Equivalent circuit, Voltage regulation and efficiency, Parallel operation. Three-phase Transformer: Various Connections and their comparative features, Harmonics in emf and magnetizing current, Effect of connections and construction on harmonics, Parallel operation of three-phase transformer, Sharing of load, 3-phase to 2-phase conversion, 3-phase to 6-phase conversion. Autotransformers: Principle of operation and comparison with two winding transformer. Solid state Transformer: Advantages, Topologies, Features, Environmental Impact, Application and challenges, Methodology

References:

1. N. Mohan., T. M. Undelandand and W. P. Robbins, *Power Electronics Converters, Applications and Design*, 3rd Ed., Wiley India, 2007
2. M. H Rashid., *Power Electronics Circuits Devices and Applications*, 3rd Ed., Pearson Education, 2009
3. I. J. Nagrath and D. P. Kothari, *Electrical Machines*, 3rd Ed., Tata McGraw-Hill Publishing Company Limited, 2017
4. M. G. Say, *The Performance and Design of Alternating Current Machines*, CBS Publishers, 2005

EE4153: ENERGY AUDITING & MANAGEMENT [3 0 0 3]

Energy Types, Needs, Scenario, Energy Security, Environmental Impact, Energy Reforms, Material & Energy Balance, Consumption Pattern, Sankey Diagram, Energy Policy, Information Systems, Energy Conservation Act 2001, Electricity Act 2003, Energy Reforms, National Action Plan for Climate Change (NAPCC), Standards & Labels , Energy Audit Purpose & Scope, Types of Energy Audit & Methodologies, Audit Instruments, Energy Management principles, Benchmarking and Strategies, Performance assessment of Electrical utilities, Performance Assessment of Thermal Utilities, Energy Economic Analysis, Role of ESCOs.

References:

1. P. W. O'Callaghan, *Energy Management A comprehensive guide to reducing costs by efficient energy use*, McGraw Hill, England, 1992.
2. A. K. Tyagi, *Handbook on Energy Audits and Management*, TERI, 2000.
3. IEEE Std. 739-1995, *IEEE recommended practice for energy management in industrial and commercial facilities*, 2000.
4. S. Doty and W. C. Turner, *Energy Management Handbook* (7e), Fairmont Press, USA, 2009.

EE4154: HVDC & FACTS [3 0 0 3]

HVDC Transmission system, merits and demerits application and schemes of HVDC, equivalent circuit diagram of a two terminal HVDC link, HVDC control, grid firing units for converters, Power flow model of HVDC. Introduction to FACTS controllers- configuration and working principle of SVC, STATCOM, TCSC, SSSC, GCSC, Switching Converter based voltage and Phase angle regulator, and UPFC, IPFC- Steady state characteristics, effect of FACTS devices on transient stability, power flow, power oscillation damping and voltage stability, Introduction to steady state and dynamic model of FACTS controllers.

References:

1. K. R. Padiyar, *FACTS Controllers in power transmission and distribution systems*, New Age International publishers, New Delhi, 2007.
2. N. G. Hingorani& L. Gyugyi, *Understanding FACTS: Concepts and Technology of flexible AC transmission systems*, IEEE Press, 2000.
3. K. R. Padiyaar, *HVDC power transmission systems, Technology and System Interactions*, New Age International publishers, New Delhi, 1999.
4. V. K. Sood, *HVDC and FACTS Controller*, Kluwer Academic Publisher, 2004

EE4155: MICROGRID [3 0 0 3]

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC

microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques. Power quality issues in microgrids- Modelling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

References:

1. N. Hatziargyriou, Microgrids *Architectures and Control*, John Wiley and Sons Ltd, 2014.
2. S. Chowdhury, S. P. Chowdhury and P. Crossley, *Microgrids and Active Distribution Networks*, The Institution of Engineering and Technology, London, U.K, 2009.
3. M. Sechilariu and F. Locment, Urban DC Microgrid, Intelligent Control and Power Flow Optimization, Elsevier, 1st Edition, 2016.

EE4156: Power System Optimization [3 0 0 3]

Review of Power flow, DC power flow, DC Optimal power flow, Classical Economic dispatch - Thermal system economic dispatch, Hydro-thermal economic dispatch. Security constrained economic dipatch, Multiarea System economic dispatch, Unit Commitment, Optimal power flow, Reactive power optimization, Optimal load shedding, Uncertainty Analysis in power system.

References:

1. J. Zhu, Optimization of Power System Optimization, John Wiley & Sons, Inc., 2009.
2. D. P. Kothari & J. S. Dhillon, Power System Optimization, PHI, 2007.
3. J. A. Momoh, Electric Power System Applications of Optimization (2e), CRC Press, 2009.

EE4157: ENERGY STORAGE DEVICES [3 0 0 3]

Introduction to different forms of energy storage. Energy storage as a structural unit of a power system, applications of energy storage- utilities, transport, industry, house hold. Energy storage techniques: Electrochemical energy storage- Secondary batteries, battery charge controller design, Fuel cells. Case Study on Electrical Vehicle- System design Consideration. Thermal energy storage, Flywheel storage, Superconducting magnetic energy storage, pumped hydro storage, Compressed air energy storage, Capacitor bank storage, Power system considerations for energy storage: Integration of energy storage systems-Effect of energy storage on transient regimes in the power system.

References:

1. A.G. Ter-Gazarian, *Energy Storage for Power Systems* (2e), IET Power and Energy Series 63, The Institution of Engineering and Technology, United Kingdom, 2011.
2. Gregory L Plett, *Battery Management Systems*, Volume- 1, Battery Modeling, Artech House Publishers, 2015.
3. Gregory L Plett, Battery Management Systems, Volume- 1, Equivalent circuit methods, Artech House Publishers, 2015.
4. R. Bove and S. Ubertini, *Modeling Solid Oxide Fuel Cells*, Springer, 2008.

EE4158: POWER QUALITY ISSUES [3 0 0 3]

Power Quality Issues: Standards and indices, Voltage sags, swell, surges, spikes, Interruptions, Harmonics: harmonic distortion of fluorescent lamps, effect of power system harmonics on power system equipment and loads, Power factor improvement, Passive Compensation, Passive Filtering, Harmonic Resonance, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC Based on Bilateral Single Phase and Three Phase Converter-static var compensators, SVC and STATCOM, Active Harmonic Filtering: Shunt Injection Filter for single phase, three-phase three-wire and three-phase four-wire systems, UPS, constant voltage transformers, series active power filtering techniques for harmonic cancellation and isolation, Dynamic Voltage Restorers, Grounding and wiring, NEC grounding requirements, solutions to grounding and wiring problems.

References:

1. S. Santoso, H. W. Beaty, R. C. Dugan, M F. McGranaghan, *Electrical Power System Quality*, Second edition, McGraw Hill Pub, 2002.
2. H. B. Math, *Understanding Power Quality Problems*, IEEE Press, 1st Edition, 2001.
3. J. Arrillaga, *Power System Quality Assessment*, John Wiley, 2000.

4. A. Ghosh and G. Ledwich, *Power Quality Enhancement using Custom Power Devices*, Kluwer Academic Publication, 2002.
5. C. Shankran, *Power quality*, CRC Press, 2001.

OPEN ELECTIVES

EE2080: SOLAR PHOTOVOLTAICS [3 0 0 3]

Solar Radiation: Spectrum, Terminologies, Measurement, Estimation; Sun-Earth Movement & Angles, Sun Tracking, PN Junction Diode & Characteristics, Solar Cell, Photovoltage, Light Generated Current, I-V equation & Characteristics: Short Circuit Current, Open Circuit Voltage, Maximum Power Point, Fill Factor, Efficiency, Losses, Equivalent Circuit, Effect of Series & Shunt Resistance, Solar Radiation, Temperature on Efficiency, Solar PV Modules: Series & Parallel connection, Hotspots, Bypass & Blocking Diodes, Power Output, Ratings, I-V & Power Curve, Effect of Solar Irradiation & Temperature, Balance of System (BOS): Batteries: Classification, Capacity, Voltage, Depth of Discharge, Life Cycle, Factors affecting Battery Performance; Charge Controllers, DC to DC Converters, DC to AC converters, Maximum Power Point Tracking (MPPT).

References:

1. C. Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Application*, PHI New Delhi, 2009.
2. G. N. Tiwari, *Solar Energy: Fundamentals, Design, Modeling and Applications*, Narosa Publications New Delhi, 2013.
3. S. Deambi, *Photovoltaic System Design*, CRC Press USA, 2016.
4. F. Kreith and D. Y. Goswami, *Energy Management and Conservation Handbook* (2e), CRC Press USA, Fairmont Press, USA, 2017.
5. J. Balfour, M. Shaw and N. B. Nash, *Advanced Photovoltaic Installations*, Jones & Barlett Learning USA, 2013.

EE2081: MATLAB FOR ENGINEERS [3 0 0 3]

MATLAB desktop, workspace variables and types, creating and calling functions, 2D & 3D plots, control flow statements, introduction to Cody Coursework platform, introduction to live script environment, interpolating & extrapolating set of data, generating, importing data from various data tools, introduction to Simulink, solving ordinary differential equations in Simulink, introduction to Simscape, development of graphical user interface with GUIDE tool.

References:

1. S. J. Chapman, *Essentials of MATLAB Programming*, BAE Systems (3e), Cengage Learning, 2008
2. C. Wilkins, *Exploring Mathematics with MuPAD*, University of Oxford, 2011
3. S. L. Eshkavilov, *MATLAB & Simulink Essentials: MATLAB & Simulink for Engineering Problem Solving and Numerical Analysis*, Lulu Publishing, 2016

EE2082: FUNDAMENTALS OF RENEWABLE ENERGY SOURCES [3 0 0 3]

Energy sources and their availability, Solar Energy - Solar radiation and measurements, solar energy storage, Solar Photo-Voltaic systems design- Wind Energy- Estimation, Maximum power and power coefficient, wind energy conversion systems, design considerations and applications. Energy from Bio-Mass- Sources of bio-mass, Biomass conversion technologies, Thermo-chemical conversion and Biochemical conversions, Anaerobic digestion and Fermentation, Bio-gas generation Pyrolysis and Liquefaction, Classification of Gasifiers, Geo-Thermal Energy, Energy plantation- Energy from the Oceans, Ocean Thermal Energy Conversion, Open and Closed Cycle plants, Site selection considerations, Origin of tides, Tidal energy conversion systems, Wave energy conversion systems, Hybrid Energy Systems.

References:

1. B. H. Khan, *Non-conventional Energy Resources*, TMH, 2009.
2. J. W. Twidell & A. D. Weir , *Renewable Energy Resources*, ELBS, 2005.
3. D. Mukherjee & S. Chakrabarti, *Fundamentals of Renewable Energy Systems*, New Age Intl., 2004.
4. G. D. Rai, *Non-Conventional Energy Sour*ces, Khanna Publishers, 2004.

EE3080: ELECTRIC VEHICLE TECHNOLOGY [3 0 0 3]

History of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, comparison between IC engine and Electric vehicle. Vehicle Fundamental: General description of vehicle movement Rolling resistance, Aerodynamic drag, grading resistance, Acceleration resistance, Dynamic equation. Electric Vehicle: Configuration of Electric Vehicle, Electric Propulsion Unit- DC machines (BLDC & BDC), Three phase A/c machines, Induction machines, switched reluctance machines. Power Convertor- DC to DC. DC to AC and AC to DC Convertors. Control Strategies for BLDC, BDC & Induction drives. Energy Source System- Types of batteries, Parameters, BMS. Types of Charger, Conductive charging, Inductive Charging, Level 1,2 & 3 Charging Scheme, charging technology for Electric vehicle charging station, Converter topologies. Charging methods- constant current (CC), constant voltage (CV), constant power (CP), Fast charging strategies of an EV battery

References:

1. S. Rajkaruna, F. Shahnia, *Plug In Electric Vehicles in Smart Grids*, Springer, 2015
2. S. Dhameja, *Electric Vehicle Battery Systems*, Newnes, 2001.
3. R. Krishnan, *Permanent Magnet Synchronous and Brushless DC Motor Drives*, CRC Press, 2009
4. R. N. Jazar, *Vehicle dynamics: theory and application*, Springer, 2017
5. P. Krause, Oleg Wasynczuk, S. D. Sudhoff and S. Pekarek, *Analysis of Electric Machinery and Drive Systems*, 3rd Edition, Wiley-IEEE Press, 2013

EE3081: INTRODUCTION TO LIGHTING DESIGN [3 0 0 3]

Visible spectrum- psychophysics of vision-photometric quantities- laws of illumination-point by point method of illuminance calcualtions -Light sources- luminaires- principles of light control elements-light Intensity distribution diagram-evaluation of total flux-illuminance and visual performance- Lumen method calculations-principles and general requirements of interior & exterior lighting for different applications- Lighting Design Examples- Energy and cost effectiveness of lighting schemes.

References:

1. IESNA New York, *Lighting Handbook* (10e), 2011.
2. J. L. Lindsey, *Applied Illumination Engineering* (2e), Fairmont Press, INC 1997.
3. D. W. Durrant, *Interior Lighting Design* (5e), Lighting Industry Federation Limited, London 1977.
4. J. B. de Boer and D. Fischer, *Interior Lighting* (2e), Philips Technical Library, 1981

EE3082: ENERGY AUDITING [3 0 0 3]

Energy Types, Needs, Scenario, Energy Security, Environmental Impact, Energy Reforms, Material & Energy Balance, Consumption Pattern, Sankey Diagram, Energy Policy, Information Systems, Energy Conservation Act 2001, Electricity Act 2003, Energy Reforms, National Action Plan for Climate Change (NAPCC), Standards & Labels , Energy Audit Purpose & Scope, Types of Energy Audit & Methodologies, Audit Instruments, Energy Management principles, Benchmarking and Strategies, Performance assessment of Electrical utilities, Performance Assessment of Thermal Utilities, Energy Economic Analysis, Role of ESCOs.

References:

1. P. W. O'Callaghan, *Energy Management A comprehensive guide to reducing costs by efficient energy use*, McGraw Hill, England, 1992.
2. A. K. Tyagi, *Handbook on Energy Audits and Management*, TERI, 2000.
3. IEEE Std. 739-1995, *IEEE recommended practice for energy management in industrial and commercial facilities*, 1995
4. S. Doty and Wayne C. Turner, *Energy Management Handbook* (7e), Fairmont Press, USA, 2009.

EE3083: ELECTRICAL ENERGY SYSTEMS [3 0 0 3]

Global Energy Scenario: Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics. Indian Energy Scenario: Energy resources & Consumption: Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption, Electrical Energy Sources: Diesel Power Plant, Hydro Electric Power Plants, Gas turbine power plant, Applications Combined operation of power plants, load division among different types of power plants, Renewable Energy: Solar, Wind, Biomass, Geothermal, tidal, Fuel Cell, Introduction to transmission and distribution systems, Protection of

electrical systems.

References:

1. M. A. El-Sharkawi, *Electric Energy – An Introduction* (2e), CRC press, 2008.
2. J. B. Gupta, *A Course in Electrical Power*, S.K. Kataria and Sons, 2013.
3. C. L. Wadhwa, *Electrical Power System* (3e), New Age Intl., 2000

B.Tech in Information Technology
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	EO2001	Economics	3	0	0	3	BB0025	Value, Ethics and Governance	2	0	0	2
	MA2101	Engineering Mathematics III	2	1	0	3	MA2201	Engineering Mathematics IV	2	1	0	3
	IT2101	Computer-System Architecture	3	1	0	4	IT2201	Web Technologies	3	1	0	4
	IT2102	Data Structures and Algorithms	3	1	0	4	IT2202	Operating Systems	3	1	0	4
	IT2103	Object-Oriented Programming	3	1	0	4	IT2203	Relational Database Management Systems	3	1	0	4
	IT2104	Data Communications	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	IT2130	Object-Oriented Programming Lab	0	0	2	1	IT2230	Operating Systems Lab	0	0	2	1
	IT2131	Data Structures and Algorithms Lab	0	0	2	1	IT2231	Relational Database Management Systems Lab	0	0	2	1
							IT2232	Web Technologies Lab	0	0	2	1
			17	5	4	24			16	4	6	23
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P) + OE		26			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	IT31XX	Program-Elective-1	3	0	0	3	BB0026	Organization and Management	3	0	0	3
	IT3101	Foundations of Data Science	3	1	0	4	IT32XX	Program-Elective-2	3	0	0	3
	IT3102	Software Engineering	3	1	0	4	IT3270	Minor-Project	0	0	4	2
	IT3103	Design and Analysis of Algorithms	3	1	0	4	XXXXXX	Open Elective – III	3	0	0	3
	IT3104	Computer Networks	3	1	0	4	IT3201	Artificial Intelligence and Machine Learning	3	1	0	4
	XXXXXX	Open Elective – II	3	0	0	3	IT3202	Automata Theory and Compiler Design	3	1	0	4
	IT3130	Design and Analysis of Algorithms Lab	0	0	2	1	IT3203	Cryptography and Information Security	3	1	0	4
	IT3131	Computer Networks Lab	0	0	2	1	IT3230	Compiler Design Lab	0	0	2	1
	IT3132	Software Engineering Lab	0	0	2	1	IT3231	Artificial Intelligence and Machine Learning Lab	0	0	2	1
			18	4	6	25			18	3	8	25
	Total Contact Hours (L + T + P) + OE		28				Total Contact Hours (L + T + P) + OE		29			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	IT41XX	Program Elective-III	3	0	0	3	IT4270	Major Project				12
	IT41XX	Program Elective-IV	3	0	0	3						
	IT41XX	Program Elective-V	3	0	0	3						
	IT41XX	Program Elective-VI	3	0	0	3						
	IT41XX	Program Elective-VII	3	0	0	3						
	IT4170	Industrial Training	0	0	2	1						
			15	0	2	16						12
	Total Contact Hours (L + T + P)		17				Total credits=169(including first year)					

THIRD SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications.

MA2101: Engineering Mathematics III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices and Boolean Algebra. Propositional and Predicate Calculus: Wellformed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. Elementary configuration: Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. Ordering of permutations: Lexicographical and Fikes. Graph theory: Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path, Algorithm. Group theory: Semi groups, Monoids, Groups subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. C. L. Liu, *Elements of Discrete Mathematics, (2e)*, Mc Graw Hill, New Delhi, 2007
2. J. P. Trembaly and R. Manohar, *Discrete Mathematics Structures with application to computer science*, Tata Mc Graw Hill, 2012
3. E. S. Page and L. B. Wilson, *An Introduction to Computational Combinatorics*, Cambridge Univ. Press, 1979
4. Narasingh Deo, *Graph theory with Applications to computer science*, PHI, 2012.

IT2101: COMPUTER SYSTEM ARCHITECTURE [3 1 0 4]

Basics of Digital Electronics: Codes, Logic Gates, Flip-Flops, Registers, Counters, Multiplexer, De-multiplexer, Encoder, Decoder; RTL and Micro Operations: Register Transfer, Bus and Memory Transfer, Logic Micro Operations, Shift Micro Operations; Basic Computer Organization: Complete Computer Description & Design of Basic Computer, Instruction Codes, Computer Instructions, Timing & Control, Instruction Cycles, Memory Reference Instructions, Input/output & Interrupts; Control Unit: Hardwired vs. Micro Programmed Control Unit, Central Processing Unit, General Register Organization, Stack Organization, Instruction Format, Data Transfer & Manipulation, Program Control, RISC, CISC; Computer Arithmetic: Addition & Subtraction, Multiplication Algorithms, Division Algorithms; Input-Output Organization: Peripheral devices, I/O interface, Data Transfer Schemes, Program Control, Interrupt, DMA Transfer, I/O Processor; Memory Unit: Memory Hierarchy, Processor vs. Memory Speed, High-speed Memory, Cache Memory, Associative Memory, Interleave, Virtual Memory, Memory Management; Introduction to Parallel Processing: Pipelining, Characteristics of Multiprocessors, Interconnection Structures, Inter-processor Arbitration, Inter-processor Communication & Synchronization; Case Studies: Case Studies of some Contemporary Advanced Architecture for Processors of Families like Intel, AMD, IBM.

References:

1. Mano Morris M, *Computer System Architecture*, (3e), Prentice Hall India, 2017.
2. C. Hamacher, Z. Vranesic, Computer Organization, (6e), Tata McGraw Hill, 2016.
3. Hayes, J. P., Computer Architecture and Organization, (3e Revised), Tata McGraw Hill, 2017.
4. Hennessy, J.L., Patterson, D.A, and Goldberg, D., Computer Architecture a Quantitative Approach, (6e), Pearson Education Asia, 2017.

IT2102: DATA STRUCTURES AND ALGORITHMS [3 1 0 4]

Introduction: Algorithm Specification; Performance Analysis: Time and Space Complexity, Asymptotic Notation, Pointer Declaration and Definition, Memory Allocation Functions, Array of Pointers, Type Definition, Enumerated Types, Accessing Structures, Complex Structures, Arrays of Structures, Structures and Functions; Linked Lists: Representations, Singly, Doubly, Header Node, Circular, Applications of Linked Lists: Josephus Problem, Sparse Matrix Storage Using Linked List and Its Operations, Polynomial and Long Integer Arithmetic; Stacks: Representing Stacks in C, Evaluation of Expressions, Multiple Stacks; Applications of Stacks: Infix, Postfix and Prefix and their Conversions, Recursive Definition and Processes, Recursion in C, Writing Recursive Programs Efficiency of Recursion; Recursion Examples: Tower of Hanoi, GCD, Fibonacci Definition; Queues: Linear and Circular Queue, Priority Queue, Linked List Representations; Trees: Basic Terminologies, Binary Tree Representation, Binary Search Tree, AVL Trees, B and B+ Trees; Tree Operations: Inserting, Deleting and Searching; Graph: Graph Operations, Spanning Trees, Minimum Cost Spanning Tree, Shortest Path and Transitive Closure; Searching: Binary and Linear Search Algorithms; Sorting: Insertion, Quick, Merge, Heap, Radix Sort; Hashing: Hashing and Collision Resolution.

References:

1. Seymour Lipschutz, *Data Structures with C (Schaum's Outline Series)*, (1e), Tata McGraw Hill Education Private Limited, ISBN: 9780070701984, , 2011.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to algorithms*, (3e), Prentice Hall India, ISBN-13: 978-0262033848, ISBN-10: 9780262033848, 2009.
3. Mark Allen Weiss, *Data structures and Algorithm Analysis in C*, (2e), Pearson Education India, ISBN:0-8053-5443-*3,* 2014.
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, *Data Structures and Algorithms*, (1e), Pearson Education India, ISBN-13: 978-0201000238, ISBN-10: 0201000237, 2012.
5. A. Tanenbaum, J. Augenstein, *Data Structures using C*, (2e), Pearson Education India, ISBN-13: 978-0130369970, ISBN-10: 0130369977 Pearson Education, 2006.

IT2103: OBJECT-ORIENTED PROGRAMMING [3 1 0 4]

Introduction: Object-oriented Paradigm and Pillars such as Abstraction, Encapsulation, Inheritance and Polymorphism; Java Basics: Compilation and Execution of a Java Program, Access Modifiers; Class and Objects: Class Definition, Creating Objects, Role of Constructors, Method Overloading, Argument Passing, Objects as Parameters, Access Control; I/O Basics: Reading Console Input, Writing Console Output; Array and Strings: Arrays in Java, 1-D, 2-D and Dynamic Arrays, String Basics, String Comparison and Manipulation; Inheritance: Inheritance and its Types, Abstract Class, Inner and Outer Class, Super, Final, Static Keywords; Package and Interface: In-Built Packages and User Define Packages, Role of Interface, Polymorphism via Inheritance; Collection Framework & Generics: List, Set, Map, Generic Classes; Exception Handling: Errors and Exceptions, Types of Exceptions, Handling Exceptions, Multithreading: Thread Class, Runnable, Thread Life Cycle, Synchronization, Thread Priority; Event Handling and GUI Programming: Events, Action Listener, Important Swing Package Classes.

References:

1. Schildt H, *Java: The Complete Reference*, (10e), Tata McGraw-Hill Education Group, 2017.
2. Balagurusamy E, *Programming with Java*, (5e), Tata McGraw Hill, 2017.
3. Daniel Liang Y, *Introduction to Java Programming*, (10e), Pearson Education, 2018.
4. Horstmann CS, *Big Java: Early Objects*, (5e), Wiley's Interactive Edition, 2015.

IT2104: DATA COMMUNICATIONS [3 1 0 4]

Data Transmission: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity; Transmission Media: Guided Transmission Media, Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission; Signal Encoding Techniques: Analog and Digital Signals; Digital-to-Digital Conversion: Line

Coding Schemes, Block Coding, Scrambling; Analog-to-Digital Conversion: Pulse Code Modulation, Delta Modulation; Digital Data Communication Techniques: Asynchronous and Synchronous Transmission, Types of Errors, Error Detection, Error Correction, Line Configurations; Media Access Control: Introduction, ALOHA, CSMA, CSMA/CD, CSMA/CA; Data Link Control Protocols: Flow Control, Error Control, High-Level Data Link Control (HDLC); Multiplexing: Frequency-Division Multiplexing (FDM), Time-Division Multiplexing (TDM), Code-Division Multiple Access (CDMA); Spread Spectrum: The Concept of Spread Spectrum, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS); Cellular Wireless Communication Techniques: Introduction,1G, 2G, 3G, 4G, and 5G.

References:

1. W. Stallings, *Data and Computer Communications*, (10e), Pearson Education India, 2014.
2. B. Forouzan, *Data Communications & Networking*, (5e), McGraw Hill, 2013.
3. L. Peterson and T. Davie, *Computer Networks: A Systems Approach*, (5e), Morgan Kaufmann Publishers, 2012.
4. K. R. Fall, W. R. Stevens, *TCP/IP Illustrated*, (2e), Addison-Wesley Publication, 2011.

IT2130: OBJECT-ORIENTED PROGRAMMING LAB [0 0 2 1]

Java Introduction: Compiling and Executing a Simple Java Program and Simple Input/Output; Class and Objects: Class Definition, Creating Objects; Array and Strings: Programs Based Upon 1-D, 2-D and Dynamic Arrays, String Comparison and Manipulation; Inheritance: Inheritance and Its Types, Abstract Class, Inner and Outer Class, Super, Final, Static Keywords; Collection Framework & Generics: Using Collection Classes such as Array Lists and Linked Lists Writing Generic Classes; Exception Handling: Errors and Exceptions, Types of Exceptions; Multithreading: Thread Class, Runnable, Synchronization, Thread Priority; Event Handling and GUI Programming: Action Listener, Swing Package.

References:

1. Schildt H, *Java: The Complete Reference*, (10e), Tata McGraw-Hill Education Group, 2017.
2. Balagurusamy E, *Programming with Java*, (5e), Tata McGraw Hill Education Group, 2017.
3. Daniel Liang Y, *Introduction to Java Programming*, (10e), Pearson Education India, 2018.
4. Horstmann CS, *Big Java: Early Objects*, (5e), Wiley's Interactive Edition, 2015.

IT 2131: DATA STRUCTURES AND ALGORITHMS LAB [0 0 2 1]

Array: Implementation and Operations on One Dimensional and Two Dimensional Array; Linked-List: Implementation and Operations on Singly, Doubly and Circular Linked Lists; Stacks: Implementation and its Applications; Queue: Implementation and its Applications; Trees: Binary Tree Implementation and its Applications; Binary Search Tree: Implementation and its Operations, AVL Tree; Graph: Implementation and Applications; Sorting: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort; Searching: Linear and Binary Search.

References:

1. Seymour Lipschutz, *Data Structures with C (Schaum's Outline Series*), (1e), Tata McGraw Hill Education Group, ISBN: 9780070701984, 2011.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to algorithms*, (3e), Prentice Hall India, ISBN-13: 978-0262033848, ISBN-10: 9780262033848, PHI, 2009.
3. Mark Allen Weiss, *Data structures and Algorithm Analysis in C*, (2e), Pearson Education India, ISBN:0-8053-5443-*3,* 2014.
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, *Data Structures and Algorithms*, (1e), Pearson Education India, ISBN-13: 978-0201000238, ISBN-10: 0201000237, 2012.
5. A. Tanenbaum, J. Augenstein, *Data Structures using C*, (2e), Pearson Education India, ISBN-13: 978-0130369970, ISBN-10: 0130369977, 2006.

FOURTH SEMESTER

IT2201: WEB TECHNOLOGIES [3 1 0 4]

Introduction: Web Development and Client Side Programming, Protocols Governing Web, Internet Services and Tools, Client-Server Computing; HTML: Basic Syntax, Standard HTML Document Structure, Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms, HTML5; CSS: Creating Style Sheets, Levels of Style Sheets, CSS Properties, Style Specification Formats, Selector Forms, The Box Model, Conflict Resolution; Javascript: Basic of Javascript, Variables, Arrays and Operators, Functions, Event Handlers, Built-in JS Objects, Form Validations, Conditional and Loops, Debugging and Testing; Introduction to AJAX: AJAX and Node.Js Server, The Xmlhttprequest Object, Handling The Response, Jquery, Passing Data, AJAX Application; PHP Programming: Introduction to PHP, Creating PHP Script, Running PHP Script, Variables and Constants, Data Types, Operators, Conditional Statements, Control Statements, Arrays, Functions, Working With Forms and Databases Connection, Introduction to Web-Server and XAMPP.

References:

1. "*Web Technologies (Black Book)*", Kogent Learning Solutions Inc., Dreamtech Press, 2009.
2. Jackson, *Web Technologies: A Computer Science Perspective*, (1e), Pearson Education India, 2007.
3. Srinivasan, *Web Technology: Theory and Practice*, (1e), Pearson Education India, 2012.
4. Godbole A., Khate A., *Web Technologies*, (3e), McGraw Hill Education, 2017.
5. Gopalan N. P., Akilandeswari J., *Web Technology: A Developer's Perspective*, (2e Revised), Prentice Hall India Learning, 2014.
6. Roy U. K., "Web Technologies", Oxford Press, 2010.

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA2201: Engineering Mathematics IV [2 1 0 3]

Basic Set theory, Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One dimensional and two dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. Functions of random variables: One dimensional and Two dimensional, F & T distributions, Moment generating functions, Sampling theory, Central limit theorem, Point estimation, MLE, Interval estimation, Test of Hypothesis : significance level, certain best tests; Chi square test.

References:

1. P. L. Meyer, *Introduction to probability and Statistical Applications*, (2e), Oxford and IBH publishing, 1980
2. Miller, Freund and Johnson, *Probability and Statistics for Engineers*, (8e), PHI, 2011.
3. Hogg and Craig, *Introduction to mathematical statistics*, (6e), Pearson education, 2012.
4. Sheldon M Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Elseveir, 2010.

IT2202: OPERATING SYSTEMS [3 1 0 4]

Introduction: Operating System Structure, Operating System Operations, Process Management, Memory Management Storage Management, Protection and Security, Special Purpose; System Structure: Operating System Services, User Operating System Interfaces System Calls, Types of System Calls, System Programs Operating System

Structure, Virtual Machines, System Boot; Process: Process Concept, Process Scheduling Operations on Processes Inter-Process Communication, Unix Pipes; Multithreaded Programming: Overview, Multithreaded Models Thread Libraries Programs Using Pthreads; Process Scheduling: Basic Concepts, Scheduling Criteria; Process Synchronization: Background, Critical Section Problem Peterson's Solution Synchronization Hardware, Semaphores Classical Problems of Synchronization Classical Problems of Synchronization. Programs Using Pthreads; Deadlocks: System Model, Deadlock Characterization Methods for Handling Deadlocks, Deadlock Prevention Deadlock Avoidance Deadlock Detection, Recovery from Deadlock; Memory Management: Background (Address Binding, Logical vs Physical Address Space, Dynamic Loading, Dynamic Linking And Shared Libraries, Overlays) Swapping, Contiguous Memory Allocation, PAGING, Structure of Page Table Segmentation, Demand Paging, Page Replacement Policies Allocation of Frames , Thrashing; File System Interface and Implementation : File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File System Structure Space Allocation Methods for Files (Contiguous, Linked , Indexed), Free Space Management (Bit Vector, Linked List, Grouping, Counting); Disk Management: Disk Scheduling Algorithms, Disk Management, Swap Space Management; Protection and Security: Goals of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, The Security Problem, User Authentication, Program Threats, System Threats Intrusion Detection.

References:

1. Avi Silberschatz, Peter Baer Galvin, Greg Gagne, *Operating System Concepts*, (9e), Wiley India, ISBN: 9788126554270, 8126554274, 2013.
2. William Stallings, *Operating Systems: Internals and Design Principles*, (9e), Pearson Education India, ISBN: 9789352866717, 2018.
3. A.S. Tanenbaum, *Modern Operating Systems*, Fourth Edition, Pearson Education India, ISBN: 9789332575776, 2016.

IT2203: RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: Database Systems, RDBMS Definition, Data Models, 3-Schema Architecture, Challenges in Building RDBMS, Different Components of a RDBMS; Relational Data Model: Concept of Relations and Its Characteristics, Schema-Instance, Integrity Constraints, E/R Model, Extended E/R Model, Converting the Database Specification In E/R and Extended E/R Notation to The Relational Schema; Relational Query Language: Relational Algebra, Tuple Relation Calculus, Domain Relational Calculus, Introduction to SQL, Data Definition in SQL, Table and Different Types of Constraints Definitions, Data Manipulation in SQL, Nested Queries, Notion of Aggregation; Relational Database Design: Functional Dependencies and Normal Forms, Armstrong's Axioms for FD's, Closure of a Set of FD's, Minimal Covers, Decomposition of Relations to Desired Normal Forms, Algorithms for 3NF and BCNF Normalization, Multi-Valued Dependencies and 4NF; Transaction Processing: Concepts of Transaction Processing, ACID Properties, Concurrency Control, Locking Based Protocols, Recovery and Logging Methods; Data Storage and Indexing: File Organizations, Primary, Secondary Index Structures, Hash-Based Indexing, Dynamic Hashing Techniques, Multi-Level Indexes, B-Tree and B+ Tree.

References:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. Ramez Elmasri, Shamkant B. Navathe, *Fundamentals of Database System*, (6e), Pearson Education India, 2013.
3. Raghu Ramakrishnan, Johannes Gehrke, *Database Management Systems*, (3e), McGraw Hill, 2014.
4. Ivan Bayross, *SQL, PL/SQL The Programming Language of Oracle*, (4e), BPB Publications, 2010.
5. C. J. Date, *An Introduction to Database Systems*, (8e), Pearson Education India, 2003.

IT2230: OPERATING SYSTEMS LAB [0 0 2 1]

Introduction: Basic UNIX Commands; Shell Programming: UNIX Shell Commands, Basics of Shell Programming, UNIX System Calls; Inter Process Communication: UNIX Inter Process Communication, Programs on Pipes, CPU Scheduling Algorithms; Pthreads: Creation and Initializing Multithreaded Programs, Deadlock: Deadlock Detection Algorithms, Deadlock Avoidance Algorithms; Memory Management: Page Replacement Algorithms, Memory Allocation Algorithms, Disk Scheduling Algorithms; Virtualization: Concept using VMware.

References:

1. Avi Silberschatz, Peter Baer Galvin, Greg Gagne, *Operating System Concepts*", (9e), Wiley, ISBN: 9788126554270, 8126554274, 2013.

2. William Stallings, “Operating Systems: Internals and Design Principles”, (9e), Pearson, ISBN: 9789332518803, 2015.
3. A.S. Tanenbaum, *Modern Operating Systems*, (4e), Pearson Education India, ISBN: 9789332575776, 2016.
4. Sumitabha Das, *Unix Concepts and Applications*, (4e), McGraw Hill Education, ISBN: 9780070635463, 2017.

IT2231: RELATIONAL DATABASE MANAGEMENT SYSTEMS LAB [0 0 2 1]

Introduction: SQL and Its Different Command Categories- DDL, DML, DQL and DCL; Integrity Constraints: Data Integrity Constraints and Built-In Functions; Case Study: Design and Implementing The Data Requirements of a Simple Database Application, Experiments on Views, Indexing, Triggers, Stored Procedures, Transaction.

References:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, *Database System Concepts*, (6e), McGraw Hill, 2013.
2. Ramez Elmasri, Shamkant B. Navathe, *Fundamentals of Database System*, (6e), Pearson Education India, 2013.
3. Ivan Bayross, *Teach yourself SQL & PL/SQL using Oracle 8i & 9i with SQLJ*, (1e), BPB Publications, 2010.

IT2232: WEB TECHNOLOGIES LAB [0 0 2 1]

Web Programming: HTML- Basic Elements, Hyperlinks, Forms, Frames; Cascading Style Sheets: Inclusion of CSS, CSS Properties; Javascript: Basic Programming, Functions, DOM, Exception Handling, Events, Jquery; Dynamic Programming Using PHP: File Handling, Database Connectivity.

References:

1. “Web Technologies (Black Book)”, Kogent Learning Solutions Inc., Dreamtech Press, 2009.
2. Jackson, *Web Technologies: A Computer Science Perspective*, (1e), Pearson Education India, 2007.
3. Srinivasan, *Web Technology: Theory and Practice*, (1e), Pearson Education India, 2012.
4. Godbole A., Khate A., *Web Technologies*, (3e), McGraw Hill Education, 2017.
5. Gopalan N. P., Akilandeswari J., *Web Technology: A Developer's Perspective*, (2e Revised), Prentice Hall India Learning, 2014.
6. Roy U. K., “Web Technologies”, Oxford Press, 2010.

FIFTH SEMESTER

IT3101: FOUNDATIONS OF DATA SCIENCE [3 1 0 4]

Descriptive Statistics: Introduction, Descriptive Statistics, Probability Distribution; Inferential Statistics: Inferential Statistics through Hypothesis Testing, Permutation and Randomization Test; Regression and ANOVA: Regression Analysis, Analysis of Variance; Machine Learning: Differentiating Algorithmic and Model Based Framework, OLS, RIDGE & LASSO Regression, KNN & Classification; Supervised Learning with Regression and Classification Technique: Bias-Variance Dichotomy, Logistic Regression, LDA, QDA, Regression and Classification Trees, SVM, Ensemble Methods, Random Forest; Prescriptive Analysis: Creating Data through Designed Experiments, Active Learning, Reinforcement Learning.

References:

1. H. Trevor et al., *The Elements of Statistical Learning*, (2e), Springer, ISBN 978-0-387-84858-7, 2009.
2. C. Douglas and C. George, *Applied Statistics and Probability for Engineers*, (3e), John Wiley and Sons, ISBN-13: 978-1118539712, 2010.
3. T.M. Mitchell, *Machine learning*, (1e), McGraw-Hill, New York, ISBN-13: 978-0070428072, 2017.
4. Kevin P. Murphy, *Machine Learning - A Probabilistic Perspective*, MIT Press, ISBN-13: 978-0262018029, 2012.

IT3102: SOFTWARE ENGINEERING [3 1 0 4]

Introduction to Software Engineering: Software Components, Software Characteristics, Software Crisis, Software Engineering Processes; Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model; Requirement Engineering Process: Analysis, Documentation, Data Flow Diagrams, SRS Document, IEEE Standards for SRS; Estimation: Estimation of Various Parameters Such as Cost, Efforts, Use Case Point, Class Point Method Estimating, Constructive Cost Models (COCOMO) and its Types, Function Point, Reusability, Object Points,

Early Design Model, Post Architecture Model, The Putnam Resource Allocation Model, Software Design, Architectural Design, Low Level Design, Modularization, Design Structure Charts, Pseudo Codes, Coupling and Cohesion Measures, Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design; Coding Standards: Code Review and Walkthrough, Code Inspection; Testing : Testing Objectives, Testing and Debugging, Test Metrics and Measurements, Various Types of Testing Methods; Software Maintenance: Categories of Maintenance, Maintenance Process, Maintenance Models, Estimation of Maintenance Cost, Regression Testing, Software Re-Engineering, Reverse Engineering, Configuration Management and Certification; Software Quality: The Management Spectrum- (The People, The Product, The Process, The Project), SEI Capability Maturity Model, Verification and Validation, SQA Plans, Software Quality Frameworks, ISO 9126 Model, Certification Case Study.

References:

1. R. S. Pressman, *Software Engineering: A Practitioners Approach*, (7e Reprint), McGraw Hill, 2016.
2. R. Mall, *Fundamentals of Software Engineering*, (4e), Prentice Hall India, 2016.
3. K. K. Aggarwal and Y. Singh, *Software Engineering*, (3e Reprint), New Age International Publishers, 2016.
4. P. Jalote, *Software Engineering*, (3e Reprint), Narosa Publishing House, 2012.
5. Subramaniam, *Software Engineering*, Pearson Education India, 2015.

IT3103: DESIGN AND ANALYSIS OF ALGORITHMS [3 1 0 4]

Basics of Algorithms and Mathematics: What is an algorithm?, Mathematics for Algorithmic Sets, Functions and Relations, Vectors and Matrices, Linear Inequalities and Linear Equations; Algorithm Analysis: A priori and a Posteriori Analysis, ime Space Trade off, Asymptotic Notations, Properties of Asymptotic Notations, Recurrence Equations, Solving recurrence equations using Substitution method and Master's method; Divide and Conquer Algorithms: Binary Search, Finding Maximum and Minimum, Merge Sort, Quick Sort, Matrix Multiplication; Greedy Algorithms: Knapsack Problem, Job Sequencing with deadline, Optimal Merge Pattern, Single Source Shortest Path, Minimum Cost Spanning Tree; Dynamic Programming: Multistage Graphs, Matrix Chain Multiplication, All-Pair Shortest Paths, Optimal Binary Search Trees, 0/1 Knapsack, Travelling Salesperson Problem, Graph Traversals, Connected Components, Spanning Trees, Bi-Connected Components; String Matching: Introduction, The Naive String Matching Algorithm, The Rabin-Karp Algorithm, String Matching with Finite Automata, The Knuth-Morris-Pratt Algorithm; Introduction to NP-Completeness: The Class P and NP, Polynomial Reduction, NP- Completeness Problem, NP-Hard Problems, Travelling Salesman Problem, Hamiltonian Problem, Approximation Algorithms.

References:

1. Horowitz E, Sahni S and Rajasekaran S, *Fundamentals of Computer Algorithms*, (2e), University Press, ISBN0-7167-83, 2007.
2. Cormen T H, Leiserson T H, Rivest R L, and Stein C, *Introduction to Algorithms*, (3e), MIT Press, ISBN-10: 9780262033848, ISBN-13: 978-0262033848, 2009.
3. Aho A V, Hopcroft J E and Ullman J D, *The Design and Analysis of Computer Algorithms*, (1e), Pearson Education India, ISBN-13: 978-0201000290, ISBN-10: 9780201000290, 2007.

IT3104: COMPUTER NETWORKS [3 1 0 4]

Network Layer: Network Layer Design Issues, Routing Algorithms, Congestion Control Algorithms, Quality of Service, MPLS. Classful Addressing, Subnetting, Classless Addressing, Variable Length Blocks, Block Allocation, NAT, Ipv4, Ipv6, Fragmentation, ARP, DHCP, ICMP, Dynamic Routing Protocols: RIP, OSPF & BGP, Multicasting Protocol: IGMP, Introduction to IPV6; Transport Layer: Transport Services, State Diagram, Elements of Transport Protocols: Addressing, Connection Establishment, Connection Release, Congestion Control: Bandwidth Allocation, Regulating the Sending Rate, UDP: UDP Header, TCP: TCP Service Model, TCP Segment Header, TCP Connection Establishment, TCP Connection Release, TCP Window Management, Timer Management; Application Layer: DNS: Name Space, Domain Resource Records, Electronic Mail: SMTP, POP, IMAP, MIME, HTTP, HTTPS, SNMP.

References:

1. Behrouz A. Forouzan, *TCP/IP Protocol Suite*, (4e), Tata McGraw Hill, ISBN-10: 0070166781, ISBN-13: 9780070166783, 2010.
2. Tanenbaum A. S., *Computer Networks*, (5e), Pearson Education India, ISBN-10: 9332518742, ISBN-13: 978-9332518742, 2013.
3. Comer D. E., *Internetworking with TCP/IP Principles, Protocols and Architecture*, (6e), Pearson Education India, ISBN-10: 1292040815, ISBN-13: 978-1292040813, 2013.

IT3130: DESIGN AND ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Analysis of Sorting and Searching Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Merge Sort and Quicksort, Linear and Binary Search; Max-Heap: Implementation and Analysis; Knapsack Problem: Implementation and Analysis using Dynamic Programming; Matrix Chain Multiplication: Implementation and Analysis Using Dynamic Programming; Coin Change Problem: Implementation and Analysis using Dynamic Programming; Knapsack Problem: Implementation using Greedy Algorithm; Graph and Searching (DFS and BFS): Implementation and Analysis of Prim's and Kruskal's Algorithms; LCS Problem: Implementation and Analysis using Greedy and Dynamic Programming.

References:

1. E. Horowitz, S. Sahni and S. Rajasekaran, *Computer Algorithms*, (2e), University Press, ISBN0-7167-83, 2007.
2. Cormen T H, Leiserson T H, Rivest R L, and Stein C, *Introduction to Algorithms*, (3e), MIT Press, ISBN-10: 9780262033848, ISBN-13: 978-0262033848, 2009.
3. Aho A V, Hopcroft J E and Ullman J D, *The Design and Analysis of Computer Algorithms*, (1e), Pearson Education India, ISBN-13: 978-0201000290, ISBN-10: 9780201000290, 2007.

IT3131: COMPUTER NETWORKS LAB [0 0 2 1]

Packet Tracer: Introduction to Packet Tracer; Networking Devices: Networking Device Components, Switch and Router Basic Commands; Topology: Designing of Star Topology using Hub and Switch, IP Configuration of End Devices; DHCP: Configuring DHCP Server; Routing: Static Routing, RIP, OSPF; VLAN: Configuring VLAN and Troubleshooting; NAT: Configuring NAT and Troubleshooting. Network Programming: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP), Network Utilities: PING, NETSTAT, IPCONFIG, IFCONFIG, ARP, TRACE-ROUTE.

References:

1. Forouzan Behrouz A., *TCP/IP Protocol Suite*, (4e), Tata McGraw Hill, ISBN-10: 0070166781, ISBN-13: 9780070166783, 2010.
2. Tanenbaum A. S., *Computer Networks*, (5e), Pearson Education India, ISBN-10: 9332518742, ISBN-13: 978-9332518742, 2013.

IT3132: SOFTWARE ENGINEERING LAB [0 0 2 1]

Requirement Preparation: Prepare Software Requirement Specification of the Project, System modelling: Function Oriented Diagram, Data Flow Diagram , Entity Relationship Diagram, Software Design using Unified Modelling Language (UML): Use Case Diagram, Class Diagram , Sequence Diagram Activity Diagram, Collaboration Diagram, Communication Diagram, State Chart Diagram, Interaction Diagram, Component Diagram and Deployment Diagram , Case Study on UML Diagram, Software Testing: Code Level Testing, Functional Testing , Manual Testing, Automated Testing using Tools.

References:

1. R. S. Pressman, *Software Engineering: A Practitioners Approach*, (7e), McGraw Hill, 2016.
2. R. Mall, *Fundamentals of Software Engineering*, (4e), Prentice Hall India, 2016.
3. K. K. Aggarwal and Y. Singh, *Software Engineering*, (3e), New Age International Publishers, 2016.
4. P. Jalote, *Software Engineering*, (3e), Narosa Publishing House, 2012.
5. Subramaniam, *Software Engineering,* (1e), Pearson Education India, 2015.

SIXTH SEMESTER

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower**.** Motivation – Introduction, Human needs,

Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit**.** Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, Essentials of Management,(1e)Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987.
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

IT3201: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING [3 1 0 4]

Artificial Intelligence: Introduction to Artificial Intelligence, Current Trends in AI, Intelligent Agents, Agent v/s Software Program, Classification of Agents, Working of an Agent, Single and Multi-Agent System, Performance Evaluation of Agents, Architecture of Intelligent Agents; AI Problems: Problem Space: Problem analysis; Problem Solving Techniques: Heuristic search Techniques; Game Playing: Min Max Algorithm, alpha beta pruning; Knowledge Representation: Semantic Networks, Propositional and Predicate Calculus, Semantics for Predicate Calculus, Theorem Prover, Inference Rules, Unification, Resolution, Refutation in Predicate Logic; Machine Learning: Introduction, Types of Learning, Supervised vs Unsupervised Learning, Concept Learning- Concept Learning as Search, Find-S, Version Spaces and Candidate Elimination Algorithm, Decision Tree Learning, Classification and Regression using Supervised Learning ANN-Introduction, Perceptron Learning, Multilayer Networks and the Back-propagation Learning.

References:

1. E. Rich, K. Knight, and S.B. Nair, *Artificial Intelligence*, (3e), McGraw Hill India, 2015.
2. S. Russell, and P. Norvig, *Artificial Intelligence: A Modern Approach*, (3e), Pearson Education India, 2009.
3. Tom M. Mitchell, *Machine Learning*, (1e India Edition), McGraw Hill Education, 2017.
4. Prateek Joshi, *Artificial Intelligence with Python*, (1e), Packt Publishing Limited, 2017.

IT3202: AUTOMATA THEORY & COMPILER DESIGN [3 1 0 4]

Introduction: Automata Theory, Mathematical Preliminaries and Notations, Set Theory, Function and Relations; Finite State Machines: Deterministic and Non-Deterministic Finite Automata, Regular Languages, Mealy and Moore Machines; Regular Sets and Regular Grammars: Chomsky Hierarchy, Regular Expressions, Regular Grammar, Pumping Lemma for Regular Languages; Context Free Languages and Grammars: Ambiguity, Methods for Transforming Grammars; Push Down Automata: Context Free Languages, Non-Deterministic Push Down Automata and Deterministic Push Down Automata, Design of NPDA and DPDA; Introduction to Turing Machine: Basics of Turing Machine, Variations of Turing Machines; Introduction to Compiler Design: Structure of a Compiler, Lexical Analysis, Recognition of Tokens; Introduction to LR Parsing: Simple LR, More Powerful LR Parsers Generators; Semantic Analysis: Syntax Directed Translations; Storage Organization: Basics of Storage Organization.

References:

1. Michael Sipser, *Introduction to the Theory of Computation*, (3e), Cengage Learning, 2014.
2. John C. Martin, *Introduction to Languages and the Theory of Computation*, (4e), Tata McGraw Hill, 2010.
3. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computations, (3e), Pearson Education India, 2006.

IT3203: CRYPTOGRAPHY AND INFORMATION SECURITY [3 1 0 4]

Introduction: Computer and Network Security Concepts, Number Theory and Finite Fields; Symmetric Ciphers: Classical Encryption Techniques, Block Ciphers – DES and AES, Block Cipher Operation, Pseudorandom Number Generators and Stream Ciphers; Asymmetric Ciphers: Principles of Public Key Cryptography, RSA, Elliptic Curve Cryptography; Cryptographic Data Integrity Algorithms: Cryptographic Hash Functions, Message Authentication

Codes, Digital Signatures; Mutual Trust: Key Distribution, PKI, User Authentication, Kerberos; Network and Internet Security: Transport Level Security, Wireless Network Security, Email Security, IP Security.

References:

1. Stallings W, *Cryptography and Network Security: Principles and Practice*, (7e), Pearson Education India, ISBN 978-1-292-15858-7, 2017.
2. Katz J, Menezes A J, Van Oorschot PC, Vanstone S A, *Handbook of Applied Cryptography*, (2e), CRC press, ISBN 0849385237, 2010.
3. Stinson Douglas R., *Cryptography: Theory and Practice*, (3e), Chapman and Hall / CRC Press, 2005.

IT3230: COMPILER DESIGN LAB [0 0 2 1]

Basic Introduction: Preliminary Scanning Applications; Lexical Analysis: Design and Implementation of Lexical Analyzer; Parsing: Design and Implementation of Parser, Implementation of Code Generator; Lex and YACC: Programs using LEX, Programs using YACC.

References:

1. *Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Compilers Principles, Techniques and Tools, (2e), Pearson Education India, 2013.*
2. *D. M. Dhamdhere, Systems Programming and Operating Systems, (2e Revised), Tata McGraw Hill, 2009.*
3. *Kenneth C. Louden, Compiler Construction - Principles and Practice, (1e), Thomson Press India, 2007.*

IT3231: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB [0 0 2 1]

Problem Solving Using Uninformed/Informed Search Techniques: Water Jug Problem using Depth First Search, TSP using Branch and Bound and Nearest Neighbor, Implementation of Hill Climbing Method, Implementation of Best First Search Method; Problem Formulation and Solving: Formulating Real World Problems for AI/ML, Classification and Regression Problems, Intuitive and Simple Algorithms, Representation of the World and Real Data, Visualization, Data Prep; Closer Look at AI/ML Algorithms: Linear Algorithms, Optimization and Training, Non-Linear Solutions and MLP, Gradient Descent and Backpropagation, Decision Trees.

References:

1. E. Rich, K. Knight, and S.B. Nair, *Artificial Intelligence*, (3e), McGraw Hill, 2015.
2. S. Russell, and P. Norvig, *Artificial Intelligence: A Modern Approach*, (3e), Pearson Education India, 2009.
3. Tom M. Mitchell, *Machine Learning*, (1e Indian), McGraw Hill, 2017.
4. Prateek Joshi, *Artificial Intelligence with Python*, (1e), Packt Publishing Limited, 2017.

IT3270:

SEVENTH SEMESTER

IT4170

EIGHT SEMESTER

IT4270:

PROGRAM ELECTIVES-II, III, IV, V, VI, VII

IT3140: SOFT COMPUTING [3 0 0 3]

Introduction to Soft Computing: Concept of Computing Systems, Soft Computing Versus Hard Computing, Characteristics of Soft Computing, Some Applications of Soft Computing Techniques; Fuzzy Logic: Introduction to Fuzzy Logic- Fuzzy Sets and Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Rules, Propositions, Implications and Inferences, Defuzzification Techniques- Fuzzy Logic Controller Design, Some Applications of Fuzzy Logic; Artificial Neural Networks: Biological Neurons and Its Working, Simulation of Biological Neurons to Problem Solving, Different ANNs Architectures, Training Techniques for ANNs, Applications of ANNs to Solve Some Real Life Problems; Nature Inspired Algorithms: Genetic Algorithms, Concept of Genetics and Evolution and its Application to Probabilistic Search Techniques, Basic GA Framework and Different GA Architectures, GA Operators- Encoding, Crossover, Selection, Mutation, etc., Solving Single-Objective Optimization Problems Using GAs, Particle Swarm Optimization- Implementation, Operators, Case Studies, Ant Bee Colony Optimization- Implementation, Operators, Case Studies.

References:

1. Martin, F., Neill, Mc. and Thro, E., *Fuzzy Logic: A Practical approach*, (1e), AP Professional, 2000.
2. Ross, T, J., *Fuzzy Logic with Engineering Applications*, (3e), Willey India, 2010.
3. Mitchell, M., *An Introduction to Genetic Algorithms*, (1e), MIT Press, 2000.
4. Goldberg, D. E., *Genetic Algorithms in Search, Optimization and Machine Learning*, (1e), Pearson Education India, 2008.
5. Rajasekaran, S. and Vijayalakshmi Pai, G. A., *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis, and Applications*, (1e), Prentice Hall India, 2011.
6. Pratihar, D. K., *Soft Computing*, (1e), Narosa Publishing, 2008.
7. Haykin, S., *Neural Networks and Learning Machines*, (3e), PHI Learning, 2011.

IT3240: DATA MINING AND WAREHOUSING [3 0 0 3]

Data warehousing: Introduction to Data Warehouse, Statistical Observation on Data, Data Types, DBMS Schemas for Decision Support , Data Mart, Data Extraction, Transformation and Load (ETL) Operations, Metadata; Online Analytical Processing (OLAP), Online Transaction Processing (OLTP), ROLAP,MOLAP, HOLAP and their Operations, Bitmap Indexing, Join Indexing, Attribute Selection Measure, BUC Cubing Method, Data Cubing, Star Tree Construction, Inverted Index; Data Mining: Introduction Data Mining & Applications, Types of Data, Pre-Processing, KDD Process; Association Rule Mining (ARM): Interestingness of Patterns, Mining Frequent Patterns, K-Frequent Item Set Mining, A-Priori Algorithm, Associations and Correlations Mining, Correlation Analysis, Constraint Based Association Mining; Classification and Prediction : Basic Concepts , Entropy, Decision Tree, Naïve Bayes Algorithm, Neural Networks, Back Propagation, Support Vector Machines, Associative Classification, Lazy Learners, Prediction; Clustering: Basic Concepts, Cluster Analysis, K-Means, Partitioning Methods, Hierarchical Clustering, Expectation Maximization, Density based Clustering, Web Mining, Text Mining, Spatial Mining, Case Study: Case Studies on Various Data Mining Techniques with Varying Data Sets.

References:

1. J.Han and M. Kambher, *Data Mining Concepts and Techniques*, (3e), Elsevier, 2007.
2. P. N. Tan, M. Steinbach and V. Kumar, *Introduction to Data Mining*, (1e), Person Education India, 2007.
3. A. Berson and S. J. Smith, *Data Warehousing, Data Mining & OLAP*, (10e), Tata McGraw – Hill, 2007.

IT4140: BIG DATA ANALYTICS [3 0 0 3]

Introduction to Big Data: Introduction, Distributed File System, Big Data and its Importance, Drivers, Big Data Analytics, Big Data Applications, Algorithms, Matrix-Vector Multiplication by MapReduce; Big Data Analytics: Analyzing Big Data, Sources of Big Data, Characteristics of Big Data (4 V's), Drivers of BDA, Types of Data, Structured vs. Unstructured Data, Data Marts, Case Study Based Tutorial, Differences Between Traditional DWDM and BDA, Limitations of Traditional RDBMS to Store and Analyses Big Data, Data science, Definition and Concepts; Data Scientists: Key Competencies and Characteristics of Data Scientists, More Discussions on Data Science, Data Wrangling, Data Mugging, Data Jujitsu, Tutorial Based on Data Science Applications, Big Data Analytics Ecosystem; State of the Practice in Analytics: Data Analytics Lifecycle and Discussions, Roles for a Successful Analytics Project, Case Study to Apply the Data Analytics Lifecycle, Analytical Databases and DW Appliances, Hadoop Distributions – Comparing Various BDA Tools; Analyzing and Exploring the Data: Challenges when Managing and Analyzing Big Data, The Role of Data Virtualization in a Big Data Environment; Big Data Platforms and Storage Options: The New Multi-Platform Analytical Ecosystem, Beyond the Data Warehouse - Analytical Databases, Hadoop and NoSQL DBMS.

References

1. EMC Education Services, *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, (1e), John Wiley & Sons, 2015.
2. Minelli, Michael, Michele Chambers, and Ambiga Dhiraj. *Big data, big analytics: emerging business intelligence and analytic trends for today's businesses*, (1e), John Wiley & Sons, 2012.
3. Bahga, Arshdeep and Vijay Madisetti, *Big data science & analytics: A hands-on approach*, (1e), VPT, 2016.

IT4141: DEEP LEARNING [3 0 0 3]

Introduction To Deep Learning: History of Deep Learning, Deep Learning Success Stories, Mcculloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm; Multi-Layer Network and Optimization Technique: Multilayer Perceptron's (Mlps), Representation Power of Mlps, Sigmoid Neurons, Gradient Descent, Feed Forward Neural Networks, Representation Power of Feed Forward Neural Networks Feed Forward Neural Networks, Back Propagation Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Adagrad, Rmsprop, Adam, Eigenvalues and Eigenvectors, Eigenvalue Decomposition, Basis; Dimension Reduction and Regularization: Principal Component Analysis and its Interpretations, Singular Value Decomposition Auto Encoders and Relation to Pca, Regularization in Auto Encoders, Denoising Auto Encoders, Sparse Auto Encoders, Contractive Auto Encoders Regularization: Bias Variance Tradeoff, L2 Regularization, Early Stopping, Dataset Augmentation, Parameter Sharing and Tying, Injecting Noise at Input, Ensemble Methods, Dropout Greedy Layer Wise Pre-Training, Better Activation Functions, Better Weight Initialization Methods, Batch Normalization Learning Vectorial Representations of Words; Convolutional Neural Networks: Lenet, Alexnet, Zf-Net, Vggnet, Googlenet, Resnet, Visualizing Convolutional Neural Networks, Guided Back Propagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks; Recurrent Neural Networks: Back Propagation Through Time (Bptt), Vanishing and Exploding Gradients, Truncated Bptt, Gru, Lstms Encoder Decoder Models, Attention Mechanism, Attention Over Images.

References:

1. J.Patterson, A.Gibson, *Deep Learning*, (1e), O'Reilly Publication, 2018.
2. Goodfellow I., Bengio Y, *Deep Learning (Adaptive Computation and Machine Learning series)*, (1e), MIT Press, 2017.
3. Shai Shalev-Shwartz , Shai Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, (3e), Cambridge University Press, 2015.

IT3141: DIGITAL IMAGE PROCESSING [3 0 0 3]

Digital Image Fundamentals: Light and Electromagnetic Spectrum, Components of Image Processing System, Image Formation and Digitization Concepts, Neighbours of Pixel Adjacency Connectivity, Regions and Boundaries, Distance Measures, Applications; Image Enhancements: Image Enhancements in Spatial Domain, Basic Gray Level Transformations, Histogram Processing Using Arithmetic/Logic Operations, Smoothing Spatial Filters, Sharpening Spatial Filters; In Frequency Domain: Introduction to The Fourier Transform and Frequency Domain Concepts, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters; Image Restoration: Various Noise Models, Image Restoration using Spatial Domain Filtering, Image Restoration using Frequency Domain Filtering, Estimating the Degradation Function, Inverse Filtering; Colour Image Processing: Colour Fundamentals, Colour Models, Colour Transformation, Smoothing and Sharpening, Colour Segmentation; Image Compression: Introduction, Image Compression Model, Error-Free Compression, Lossy Compression; Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding; Representation: Boundary Descriptors.

References:

1. Gonzalez R. C., Woods R. E., *Digital Image Processing*, (4e), Pearson Education India, ISBN. 978-0131687288, 2017.
2. Jain A. K., *Fundamentals of Digital Image Processing*, (1e), Pearson Education India, ISBN: 9789332551916, 933255191X, 2015.
3. J. Burge Mark & Burger Wilhelm, *Principles of Digital Image Processing*, (1e), Springer, 2011.

IT3241: COMPUTER VISION [3 0 0 3]

Introduction : Image Processing, Computer Vision, Low-Level Computer Vision, Mid-Level Computer Vision, High-Level Computer Vision, Overview of Diverse Computer Vision; Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality, Image Formation, Image Representations (Continuous And Discrete) , Image Pre-Processing Techniques; Feature Extraction: Point, Line And Edge Detection, Color, Texture, Shape and Structure Features In Spatial and Frequency Domains, Corner Detection, Hough Transform; Image Segmentation: Gray-Level Thresholding, Supervised Vs. Unsupervised Thresholding, Banalization Using Otsu's Method, Locally Adaptive Thresholding, Color-Based Segmentation, Region Oriented Segmentation, Use of Motion in Segmentation, Spatial Techniques, Frequency Domain Techniques, Representation and Description- Boundary and Region Descriptors; Object Recognition: Statistical and Structural Recognition, Recognition Based on Decision Theoretic Methods, Minimum Distance Classifier, Optimum Statistical Classifier; Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-Supervised, Semi-Supervised; Classifiers: Bayes, KNN, ANN Models.

References:

1. A. F. David, J. Ponce, *Computer vision – A Modern Approach*, (2e), Pearson Education India, ISBN-13: 978-9332550117, 2015.
2. R. C. Gonzalez, R. E. Woods. *Digital Image Processing*, (4e), Pearson Education India, ISBN 978-0131687288, 2017.
3. R. Klette, *Concise Computer Vision: An Introduction into Theory and Algorithms*", (1e), Springer, ISBN-10: 1447163192, ISBN-13: 978-1447163190, 2014.

IT4142: PARALLEL COMPUTING [3 0 0 3]

Multi-Core Architecture: Introduction, Need for Multicore-architectures, Laws of Parallel Programming, Amdahl's Law, Gustafson's Law, Moore's Law; Basic Introduction to OpenMP Programming Model: Subroutines, Compiler Directives, Threading and Parallelism, Scheduling Clauses, Concurrency and Locks, Case Studies; Many-Core Architecture: Heterogeneous Parallel Computing, Architecture of Modern GPU, Parallel Programming Languages and Models, History of GPU Computing , Introduction to Data Parallelism, Data Parallelism and CUDA C, CUDA Program Structure, Device Global Memory and Data Transfer, Kernel Functions and Threading; Data-Parallel Execution Model: CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix-matrix Multiplication, Synchronization and Transparent Scalability, Assigning Resources to Blocks, Thread Scheduling and Latency Tolerance; CUDA Memories: Importance of Memory Access Efficiency, CUDA Device Memory Types, Strategy for Reducing Global Memory Traffic, Tiled Matrix Multiplication, Memory as Limiting Factor to Parallelism; Performance Considerations: Warps and Thread Execution, Global Memory Bandwidth, Dynamic Partitioning of Execution Resources, Instruction Mix and Thread Granularity; Parallel Patterns: Convolution -1D/2D, Constant Memory and Caching, Prefix Sum, Sparse Matrix Vector Multiplication, Programming Models and Important Trends in Heterogeneous Parallel Computing, Case Studies; MPI Programming Model Introduction: Distributed Memory Programming with MPI, Compilation and Execution using MPI_Init and MPI_Finalize, Communicators using MPI_Comm_size and MPI_Comm_Rank, Communication using MPI_send And MPI_receive.

References:

1. Kirk, David B., and W. Hwu Wen-Mei, *Programming massively parallel processors: a hands-on approach*", (3e), Morgan Kaufmann, 2016.
2. Rohit Chandra, David Kohr, Dror Maydan, Jeff McDonald, *Parallel Programming in OpenMP*, (1e), Morgan Kaufmann, 2018.
3. Grama, Ananth, *Introduction to parallel computing*, (2e), Pearson Education India, 2003.
4. Peter S. Pacheo, *Parallel programming with MPI*, (1e), Morgan Kaufmann, 1997.
5. Shane Cook, *CUDA Programming: A Developer's Guide to Parallel Computing with GPUs*, (1e), Morgan Kaufmann, 2012.

IT4143: ADVANCE COMPUTER VISION [3 0 0 3]

Introduction: Fundamentals of Object Recognition, Low-Level Computer Vision-Edges, Contours, Textures, Shapes and Colors, Motion, Optical Flow and Tracking, Local Features, Invariance, Bag-of-Words Models, Fisher Vector, Middle-Level Representations of Objects: Parts, Attributes, Embedding, etc., Machine Learning and Computer Vision: Clustering and Segmentation, Supervised Classification and Object/Scene/Attribute/Activity Recognition,

Probabilistic Models and Fisher Vectors, Learning to Rank and Image Retrieval, Dimensionality Reduction, Manifold Learning, and Image, Convolutional Neural Networks and Large-Scale Image Classification, Recurrent Neural Network, Long Short-Term Memory and Image and Video Captioning.

References:

1. R. Szeliski, *Computer vision: algorithms and applications*, (1e), Springer Science & Business Media. ISBN. 978-1-84882-934-3, 2010.
2. S.J. Prince, *Computer vision: models, learning, and inference*, (1e), Cambridge University Press, ISBN-13: 978-1-1107-01179-3, 2012.
3. R. Klette *Concise Computer Vision: An Introduction into Theory and Algorithms*, (1e), ISBN-10: 1447163192, ISBN-13: 978-1447163190, Springer, 2014.

IT4144: ADVANCED DATA STRUCTURES [3 0 0 3]

Red-Black Trees: Properties of Red-Black Trees, Rotations, Insertion and Deletion in Red-Black Trees, Analysis of Operations, Fibonacci Heaps: Structure of Fibonacci Heaps, Mergeable-heap Operations, Decreasing a Key and Deleting a Node, Bounding the Maximum Degree. Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Quadratic Probing, Double Hashing. Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists. Splay Trees: Splaying, Search and Update Operations on Splay Trees. NP-Completeness: P and NP, Important NP-Complete Problems. Sorting: Bucket Sort, Radix Sort, Topological Sort. Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

References:

1. Goodrich M T, Tamassia R, *Algorithm Design*, (2e), John Wiley, ISBN: 978-81-265-0986-7, 2013.
2. Cormen T H, Leiserson C E, Rivest R L, and Stein C, *Introduction to Algorithms*, (3e), MIT Press, ISBN:978-81-2-3-4007-7, 2009.
3. Horowitz E, Sahni S, and Rajasekaran S, *Fundamentals of Computer Algorithms*, (2e), Galgotia Publications, ISBN:81-7515-257-5, 2010.

IT4145: DISTRIBUTED COMPUTING [3 0 0 3]

Introduction: Multiprocessor Vs Multicomputer Systems, Distributed Communication Models, Remote Procedure Call, Publish/Subscribe Model, Design Issues and Challenges; Logical Time: Scalar/Vector Time and Their; Global Snapshot: Snapshot Algorithms for FIFO/ Non-FIFO Channels. Terminology and Basic Algorithms: Topology Abstraction and Overlays, Complexity Measures and Metrics, Program Structure, Elementary Graph Algorithms; Message Ordering and Group Communication: Message Ordering Paradigms, Asynchronous Execution with Synchronous communication, Group Communication, Causal Order (CO), Total order; Termination Detection: Termination Detection using Distributed Snapshots, Termination Detection by Weight Throwing, A Spanning-Tree-based Termination Detection Algorithm, Message-Optimal Termination Detection; Distributed Mutual Exclusion Algorithms: Lamport's, Ricart–Agrawala, Singhal's Dynamic Information-Structure Algorithm, Lodha and Kshemkalyani's Fair Mutual Exclusion Algorithm, Quorum-based Mutual Exclusion Algorithms, Maekawa's Algorithm, Agarwal–El Abbadi Quorum-based Algorithm, Token-based Algorithms, Suzuki–Kasami's Broadcast Algorithm, Raymond's Tree-based Algorithm; Deadlock Detection in Distributed Systems: Models of Deadlocks. Knapp's Classification, Mitchell and Merritt's Algorithm, Chandy–Misra–Haas Algorithm for the AND and OR models, Kshemkalyani–Singhal Algorithm for the P-out-of-Q model; Distributed Shared Memory: Memory Consistency Models, Shared Memory Mutual Exclusion, Wait-Freedom, Register Hierarchy and Wait-Free Simulations, Wait-Free Atomic Snapshots of Shared Objects; Check-Pointing and Rollback Recovery: Checkpoint-based Recovery, Log-based Rollback Recovery, Koo–Toueg Coordinated Check Pointing Algorithm, Juang–Venkatesan Algorithm for Asynchronous Check Pointing and Recovery, Manivannan–Singhal Quasi-Synchronous Checkpointing Algorithm, Peterson–Kearns Algorithm based on Vector Time; Consensus and Agreement Algorithms: Agreement in a Failure-Free System (synchronous or asynchronous), Agreement in (Message-Passing) Synchronous Systems with Failures, Agreement in Asynchronous Message-Passing Systems with Failures.

References

1. Kshemkalyani, A D and Singhal, M *Distributed Computing: Principles, Algorithms, and Systems,* (1e), Cambridge University Press, ISBN-10: 0521189845, ISBN-13: 0521189842, 2013.
2. Garg, V K *Elements of Distributed Computing*, (1e), John Wiley, ISBN-10: 9788126551750, ISBN-13: 978-8126551750, 2014.
3. S. K. Basu, *Parallel and Distributed Computing: Architecture and Algorithms*, (1e), Prentice Hall India, ISBN-10: 9788120352124, ISBN-13: 978-8120352124, 2016.
4. M.L. Liu, *Distributed Computing: Principles and Applications*, (1e), Pearson Education India, ISBN-10: 9788131713327, ISBN-13: 978-81317133272004, 2004.

IT4146: SOFTWARE TESTING TECHNIQUES [3 0 0 3]

Perspective on Testing: Software Testing Principles, Basic Definitions, Test Cases, Role of Discrete Math and Graph Basics for Testers; Black-Box Testing Approaches: Boundary Value Testing, Equivalence Class Testing, Decision Table Testing; White-Box Testing Approaches: Path-Based Testing, Coverage Metrics, Data Flow Testing; Program Mutation: Mutation and Mutants, Test Assessment using Mutation, Mutation Operators; Regression Testing: Regression Test Process, Execution Trace Method, Dynamic Slicing; Integration-Testing: Decomposition-Based, Call Graph-Based, Path-Based; Object-Oriented Testing: Issues, Object-Oriented Unit Testing, Object-Oriented Integration Testing and Object-Oriented System Testing.

References:

1. P. Jorgensen, *Software Testing: A Craftsman's Approach*, (4e), Shroff Publishers and Distributors, 2008.
2. A. Mathur, *Foundations of Software Testing*', (2e), Pearson Education India, 2013.
3. Srinivasan Desikan, Gopalaswamy Ramesh, *Software Testing: Principles and Practices*, (1e), Pearson Education India, 2010.
4. B. Beizer, *Software Testing Techniques*, (2e), Wiley-Dreamtech India, 2003.

IT4147: SOFTWARE RELIABILITY [3 0 0 3]

Software Metrics: Categories of Metrics, Token Count, Object-Oriented Metrics, Shyam Chidamer and Chris Kemerer's Metrics Suite, Basics of Reliability Theory: Software Reliability Attributes and Specification, Concept of Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Bathtub Curve for Hardware Reliability & Software Reliability ,Software Reliability Metrics, Availability , Software Reliability Models, Software Reliability Problems, Modelling Process, Reliability Growth Models, The Rayleigh Model, Software Reliability Allocation Models, Criteria for Model Evaluation, Optimal Reliability Allocation, Software Quality: Quality Planning and Control, Quality Improvement Process, Evolution of Software Quality Assurance (SQA), Major SQA Activities, Major SQA Issues, Zero Defect Software. Trending Reliability Techniques, Predicting Reliability Techniques, Error Seeding, Failure Rate, Curve Fitting, Software Quality Models,

References:

1. J. Musa, *Software Reliability Engineering: More Reliable Software*, (2e), McGraw Hill, 2005.
2. S. Yamada, *Software Reliability Modelling: Fundamentals and Applications*, (1e Reprint), Springer, 2014.
3. R. Mall, *Fundamentals of Software Engineering*, (4e), Prentice Hall India, 2016.
4. K. K. Aggarwal and Y. Singh, *Software Engineering*, (3e Reprint), New Age International Publishers, 2016.

IT4148: OBJECT-ORIENTED DESIGN AND PATTERNS [3 0 0 3]

Introduction: Class and Object Basics, Crash Course in Java Basics such as Packages, Exceptions, Generics and Collections; Object-Oriented Design Process: Identifying Classes and their Responsibilities, Identifying Relationships among Various Classes, Use Cases, CRC Cards, Class Diagrams, Sequence and State Charts; Class Design Guidelines: Designing and Implementing the Interface of a Class, The Importance of Encapsulation, Analyzing the Quality of an Interface, Programming by Contract such via Preconditions, Post-conditions and Invariants; Interface Types and Polymorphism: Understanding Java's Interface Concept with Focus on Polymorphism, Icon, Comparable and Comparator Interfaces; Software Design Patterns: What is Pattern, Components of a Pattern, Types of Pattern; Creational Patterns: Abstract Factory, Factory Method, Singleton; Structural Patterns: Adapter, Bridge, Composite, Decorator, Façade, Flyweight, Proxy; Behavioral Patterns: Chain of Responsibility, Command, Interpreter, Iterator, Observer, State, Strategy and Visitor; Java Object Model: Java Type System, Type Enquiry and Reflection, Generic Types; Frameworks: Role of Framework, Understanding Applet, Collections and Graph Editor Frameworks of Java.

References:

1. C. Horstmann, *Object-Oriented Design and Patterns*, (2e), Wiley India, 2012.
2. E. Gamma, R. Helm, R. Johnson, J. Vlissides *Design Patterns: Elements of Reusable Object-Oriented Software*", (1e), Pearson Education India, 2015.
3. E. Freeman, E. Robson, B. Bates, K. Sierra *Head First Design Patterns: A Brain-Friendly Guide*, (1e), Shroff/O'Reilly, 2016.
4. M. Casciaro, *Node.js Design Patterns*, (2e Revised), Packt Publishing Limited, 2016.
5. M. Blaha, *Object-Oriented Modeling and Design with UML*, (2e), Pearson Education India, 2011.

IT4149: WIRELESS AD-HOC AND SENSOR NETWORKS [3 0 0 3]

Fundamentals of Wireless Communication: Electromagnetic Spectrum, Radio Propagation Mechanisms, Characteristics of the Wireless Channel; Mobile Ad Hoc Networks (MANETs): Concepts and Architectures, Applications of Manets; MAC Protocols for Manets: Issues in Designing a MAC Protocol, Classification of MAC Protocols, Contention based Protocols, Contention based Protocols With Reservation Mechanisms, Contention based Protocols with Scheduling Mechanisms, IEEE 802.11-MAC; Routing and Transport Layer Protocols in Manets: Issues in Designing a Routing and Transport Layer Protocol, Proactive, Reactive (On-Demand) and Hybrid Routing, Transport Layer Solutions, TCP over Ad Hoc Wireless Networks; Wireless Sensor Networks (WSN): Concepts and Architectures, Applications of WSN; WSN and MAC Protocols: Single Node Architecture, Hardware and Software Components of a Sensor Node, WSN Network Architecture, Data Relaying and Aggregation Strategies, MAC Layer Protocols, Self-Organizing, Hybrid TDMA/FDMA and CSMA Based IEEE 802.15.4-MAC; WSN Routing, Localization and QOS: Issues in WSN Routing, OLSR- Localization, Indoor and Sensor Network, Absolute and Relative Localization, Triangulation-QOS, Energy Efficient Design, Synchronization, Transport Layer Issues.

References:

1. Murthy Siva Ram C., Manoj B. S., *Ad Hoc Wireless Networks: Architectures and Protocols*, (1e), Pearson Education India, 2006.
2. Cordeiro C. De Morais, Agrawal D. P, *Ad Hoc & Sensor Networks: Theory and Applications*, (2e Revised), World Scientific Publishing Company, 2011.
3. Zhao Feng, Guibas Leonides, *Wireless Sensor Networks*, (1e), Elsevier India, 2005.
4. Karl Holger, Willig Andreas, *Protocols and Architectures for Wireless Sensor Networks*, (1e), Wiley India, 2011.
5. Sohraby Kazem, Znati Daniel Minoli, Taieb, "Wireless Sensor Networks-Technology, Protocols, and Applications", (1e), Wiley India, 2010.
6. Hac Anna, "Wireless Sensor Network Designs", (1e), Wiley-Blackwell, 2003.
7. NPTEL Course: https://onlinecourses.nptel.ac.in/noc17_cs07/preview.

IT4150: CLOUD COMPUTING [3 0 0 3]

Clouds and Cloud Computing: Basic Concepts, Cloud Classifications, and Types of Services, Deployment Models; Classic Data Center (CDC): DBMS Concepts, CDC Drawbacks and Need of Cloud Resources, CDC Management and Case Studies; Virtualized Data Center (VDC): Compute and Storage, Compute Virtualization Overview, Compute Virtualization Techniques, Virtual Machines, VM Resource Management Techniques, Physical to Virtual Conversion, Hypervisor Management Software, Virtual Infrastructure Requirements; Storage: Storage Virtualization Review, Virtual Machine Storage, Block Level and File Level Virtualization, Virtual Provisioning and Automated Storage Tiering; Networking: VDC Networking Overview, VDC Networking Components, VLAN and VSAN Technologies, Network Traffic Management, Exercise – VDC Networking; Desktop and Application: Desktop Virtualization, Application Virtualization, Business Continuity in VDC, Fault Tolerance Mechanism in VDC, Backup in VDC, Replication and Migration in VDC, Cloud Infrastructure and Service Creation, Cloud Service Management; Security: Security Basics, Cloud Security Concerns and Threats, Cloud Security Mechanisms, Access Control and Identity Management in Cloud, Governance, Risk and Compliance, Security Best Practices for Cloud, Cloud Migration; Issues in Cloud Considerations: Migration Considerations, Security Issues at Different Phases to Adopt the Cloud.

References:

1. Josyula, Venkata, Malcolm Orr, and Greg Page. *Cloud computing: Automating the virtualized data centre*, (1e), Cisco Press, 2011.
2. Ray Rafaels. *Cloud computing*, (2e), CreateSpace Independent Publishing Platform, 2018.

3. Buyya, Rajkumar, James Broberg, and Andrzej M. Goscinski, *Cloud computing: Principles and Paradigms*", (1e), John Wiley & Sons, 2010.

IT4151: SOFTWARE DEFINED NETWORKS [3 0 0 3]

Introduction to Networking: TCP/IP Protocol Suite, Distance Vector and Link State Routing Algorithms, Network Protocols (ARP, BGP) and Network Topologies; Introduction to SDN: Overview, History and Evolution of SDN, Architecture of SDN, SDN Flavours, Scalability (Data Centres, Service Provider Networks, ISP Automation), Reliability (QOS, and Service Availability), Consistency (Configuration Management, and Access Control Violations), Opportunities and Challenges; Control and Data Plane Separation: Introduction to Openflow- History and Evolution, Control and Data Plane Separation, Virtual Networking, Use-Cases (Network Access Control, Virtual Customer Edge, Datacentre Optimization); Network Virtualisation: Abstraction of Physical Network (Constrained Forwarding Model, Distributed State, Detailed Configuration), Components of a Virtual Network (Virtual Switch, Bridge, Host-Virtual Adapter, NAT Device, DHCP Server, Network Adapter), Network as a Service (Naas); Applications of SDN: Network Management, Resource Utilization, Network Service Chaining, Bandwidth Calendaring and Network Programmability; SDN Design and Development: Mininet- Applications, Network Virtual Machines, SDN Controller (POX, Floodlight, Opendaylight), Applicability of Openflow Protocols in SDN Controllers.

References:

1. Nadeau T. D., Gray K., *SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies*, (1e), Shroff Publishers, 2013.
2. Goransson P., Black C., *Software Defined Networks: A Comprehensive Approach*", (2e), Morgan Kaufmann, 2016.
3. F. Hu, *Network Innovation through Open Flow and SDN: Principles and Design*, (1e), CRC Press, 2014.
4. Tiwari V., *SDN and Open Flow for Beginners with hands on labs*, (Kindle Edition), Amazon Asia-Pacific Holdings Digital Services, 2013.
5. Subramanian S., "Software Defined Networking with OpenStack", (Kindle Edition), Packt Publishing Ltd., 2016.

IT4152: MOBILE COMPUTING [3 0 0 3]

Introduction: Mobile Computing vs Wireless Networking, Mobile Computing Applications, Characteristics of Mobile Computing, Structure of Mobile Computing Applications; MAC Protocols: Wireless MAC Issues, Fixed Assignment Schemes, Random Assignment Schemes, Reservation based Schemes; Mobile Internet Protocol and Transport Layer: Overview and Features of Mobile-IP, Key Mechanism in Mobile-IP, Route Optimization; Mobile Telecommunication System: Global System for Mobile Communication (GSM), General Packet Radio Service (GPRS), Universal Mobile Telecommunication System (UMTS); Mobile Platforms and Applications: Device Operating Systems, Special Constrains and Requirements, Commercial Mobile Operating Systems; Software Development Kit: Ios, Android, Blackberry, Windows Phone; M-Commerce: Structure, Pros and Cons, Mobile Payment System, Security Issues.

References:

1. Schiller Jochen, *Mobile Communications*, (2e), Pearson Education India, 2008.
2. Pattnaik P. K., Mall Rajib, *Fundamentals of Mobile Computing*, (2e), Prentice-Hall of India, 2015.
3. Agarwal D. P., Qing, An Zeng, *Introduction to Wireless and Mobile systems*, (3e), Cengage Learning India, 2010.
4. Hansmann Uwe, Merk Lothar, Nicklons Martin S., Stober Thomas, *Principles of Mobile Computing*, (2e), Dreamtech Press, 2006.
5. William. C. Y. Lee, *Mobile Cellular Telecommunications-Analog and Digital Systems*, (2e), McGraw Hill Education, 2017.

IT4153: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Introduction: Ambiguity and Uncertainty in Language, Processing Paradigms, Phases in Natural Language Processing, Applications, Text Representation in Computers, Encoding Schemes; Linguistics Resources: Introduction to Corpus, Elements in Balanced Corpus, Wordnet, Verbnet; Part of Speech Tagging: Stochastic POS Tagging, Hmm, Transformation based Tagging, Handling of Unknown Words, Named Entities, Multi Word Expressions; Natural Language Grammars: Lexeme, Phonemes, Phrases and Idioms, Word Order, Agreement, Tense, Aspect, Mood and Agreement, Context Free Grammar, Spoken Language Syntax; Parsing-Unification, Probabilistic Parsing, Tree-Bank;

Semantics: Meaning Representation, Semantic Analysis, Lexical Semantics, Wordnet; Word Sense Disambiguation: Selection Restriction, Machine Learning Approaches, Dictionary based Approaches; Discourse: Reference Resolution, Constraints on Co-Reference, Algorithm for Pronoun Resolution, Text Coherence, Discourse Structure; Applications of NLP: Spell-Checking, Text Summarization and Information Retrieval, Sentiment Analysis.

References:

1. D. Jurafsky, J. H. Martin, *Speech and Language Processing*", (2e), Pearson Education India, ISBN-13: 978-0131873216, 2009.
2. Bikel, Daniel, and Imed Zitouni, *Multilingual Natural Language Processing Applications: From Theory to Practice*, (1e), Pearson Education India, 2012.
3. T. Siddiqui, U. S. Tiwary, *Natural language processing and Information retrieval*", (1e), Oxford University Press, ISBN-13: 978-0195692327, 2008.

IT4154: INFORMATION RETRIEVAL [3 0 0 3]

Introduction to Information Retrieval: Mathematical Basics, Vector spaces and Similarity, Probabilities and Statistics, Text Analysis; Pre-processing: Document processing, Stemming, String Matching, Basic NLP tasks – POS Tagging Shallow Parsing; Overview of Text Retrieval Systems: System Architecture, Boolean Models, Inverted Indexes, Document Ranking, IR Evaluation; Retrieval Models and Implementation: Vector Space Models, TF-IDF Weighting, Retrieval Axioms, Implementation Issues, Probabilistic Models; Statistical Language Models: Okapi/BM25, Language Models, KL-divergence, Smoothing; Query Expansion and Feedback: Query Reformulation, Relevance feedback, Pseudo-Relevance Feedback, Language Model Based, Feedback; Web Search Engines: Models of the Web, Web Crawling; Static Ranking: Page Rank HITS, Query Log Analysis, Adversarial IR, Information Filtering: Adaptive Filtering, Collaborative Filtering, User Interfaces, Text Classification, Naïve Bayes, K-nearest neighbours, Feature selection, Semi-supervised Learning; Text Clustering: Vector-space Clustering; K-means, EM algorithm, Text shingling; Graph-Based Methods: WordNet, Document and Word Graphs, Network Analysis, Random Walks, Harmonic Functions.

References:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, *Introduction to Information Retrieval*", (2e), Cambridge University Press, 2015.
2. B. Croft, D. Metzler, T. Strohman, *Search Engines: Information Retrieval in Practice*, (3e), MIT Press, 2016.
3. Chengxiang Zhai, *Statistical Language Models for Information Retrieval (Synthesis Lecture Series on Human Language Technologies)*, (2e), Morgan & Claypool Publishers, 2017.

IT4155: NETWORK SECURITY AND MANAGEMENT [3 0 0 3]

Basics of Network Security: Attacks, Services and Mechanisms; Network Security Applications: Kerberos, IPSec, SSL, TLS and VPN; Internet Security: Digital Certificate, PKI, Secure Electronic Payment System and Protocols; Issues in Network Security and Tools: Man in the Middle Attack, Replay, ARP Poisoning, DNS Poisoning, Web based Attacks; Firewalls and IDS: Need of Firewalls, Firewall Characteristics and Access Policy, Type of Firewall, Firewall Basing, Firewall Location and Configuration, Types of Intrusion Detection System, Working of IDS and Policies; Malware: Virus, Worm, Trojan Horse, Working of Malwares, Identifications and Remedies; Network Management: Requirements, IP Network Management, IP-Based Service Implementation, Network Management Architecture, SLA and Network Monitoring, MPLS Network Management, Policy-based Network Management Fundamentals.

References:

1. Pachghare V. K., *Cryptography and Information Security*, (2e Revised), Prentice Hall India, ISBN-10: 9788120350823, ISBN-13: 978-8120350823, 2015.
2. William Stallings, *Cryptography and Network Security*, (6e), Pearson Education Inida, ISBN-13: 9780133354690, 2014.
3. A. Farell, S. Abeck, *Network Management Know It All*, (1e), Morgan Kaufmann Publishers, ISBN 9780123745989,2011.

OPEN ELECTIVES

IT2080: PYTHON PROGRAMMING [3 0 0 3]

Python Concepts: Introduction to Python, Variables, Keywords, Identifiers, Literals, Operators, Comments; Control

Statement: if, if else, else if, nested if, for loop, while loop, do while, break, continue, pass; Python OOPs: OOPs Concepts, Object, Class, Constructors, Inheritance; Data structures: List, Tuple, Set, Dictionary; Functions: Functions overview, lambda function, Recursive functions, map, filter and reduce; File and Exception handling: Create a file, read and write operation with file, Introduction to Exceptions & Errors, Handling exceptions using try-except-else-finally; Numpy: Introduction to Numpy, indexing and Boolean indexing, Datatypes and Operations: statistical, Sorting, and Set Operations, Broadcasting, Speed Test –Numpy array vs. list; Pandas: Pandas and its features, Creating Series and Data Frame with data inputs, learning how to handle missing values, Handling vectorized operations, Viewing, selecting, and accessing elements in a data structure; Matplotlib: Data visualization and its importance, matplotlib and its data visualization features, types of plots; Scipy: Introduction, characteristics and sub-packages of SciPy.

References:

1. A. Martelli,"Python in a Nutshell", (3e), Shroff/O'Reilly, 2017.
2. J. Georzen, T. Bower, B. Rhodes, "Foundations of Python Network Programming: The comprehensive guide to building network applications with Python", (2e), APress, 2010.
3. William McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython", (2e), Shroff/O'Reilly, 2017.

IT3080: BASICS OF INFORMATION SECURITY [3 0 0 3]

Introduction: Elements of Information Security, Security Techniques, Category of Information Security, Security Services, Basic Network Security Terminology, Security Attacks. Encryption Techniques: Symmetric and Asymmetric Encryption Methods, Basics of Cryptanalysis, Steganography, Number Theory, Diffie-Hellman Key Exchange, Authentication Methods and Message Digest, Introduction to Digital Signatures. Network Security: Email Security, IP Security, Web Security. Special Topics to Information Security: Intrusion Detection, Malicious Software, Firewall, Computer Forensics.

References:

1. V. K. Pachghare, *Cryptography and Information Security*, (2e), Prentice Hall India, ISBN-10: 9788120350823, ISBN-13: 978-8120350823, 2015.
2. William Stallings, *Cryptography and Network Security*, (6e), Pearson Education India, ISBN-13: 9780133354690, 2014.
3. Stinson Douglas R., *Cryptography: Theory and Practice*, (3e), Chapman and Hall / CRC Press, 2005.

IT3081: BASICS OF LINUX PROGRAMMING [3 0 0 3]

Introduction: Unix System Overview, Program and Processes, Error Handling, User Identification, Signals, System Calls and Library Functions; File I/O: File Descriptors, Function for File Modification, I/O Efficiency, File Sharing, Atomic Operations; Directories: Stat, Fstat and Lstat Functions, File Types, Set-User-ID and Set-Group-ID, File Access Permissions, Function for Modifying File Permission and Ownership, Symbolic Links; System Data Files and Information: Password File, Shadow Passwords and Other Data Files; Process Environment: Process Termination, Memory Layout of a C Program, Memory Allocation, Setjmp and Longjmp Functions; Process Control: Fork Function, Vfork Function, Exit Functions, Wait and Waitpid Functions, Race Conditions, Changing User IDs and Group IDs; Process Relationship: Logins, Process Groups, Sessions, Controlling Terminal, Job Control; Signals: Signal Concepts, Functions to Raise and Handle Signals, Program Termination, Abort and System Functions; Threads: Thread Concepts, Creation, Termination and Synchronization, Threads Control, Threads and Signals, Threads and Fork, Threads and I/O.

References:

1. W R Steven, S A Rago, *Advanced Programming in the Unix environment*, (2e), Addison Wesley, 2011.
2. Y P Kanetkar, *Unix Shell Programming*, (1e), BPB Publication, 2009.

IT3082: INTRODUCTION TO DATA SCIENCE [3 0 0 3]

Descriptive Statistics: Introduction, Descriptive Statistics, Probability Distribution; Inferential Statistics: Inferential Statistics through Hypothesis Testing, Permutation and Randomization Test; Regression and ANOVA: Regression Analysis, Analysis of Variance; Machine Learning: Differentiating Algorithmic and Model Based Framework, OLS, RIDGE & LASSO Regression, KNN & Classification; Supervised Learning with Regression and Classification Technique: Bias-Variance Dichotomy, Logistic Regression, LDA, QDA, Regression and Classification Trees, SVM, Ensemble Methods, Random Forest.

References:

1. H. Trevor et al., *The Elements of Statistical Learning*, (2e), Springer, ISBN 978-0-387-84858-7, 2009.
2. C. Douglas and C. George, *Applied Statistics and Probability for Engineers*, (3e), John Wiley and Sons, ISBN-13: 978-1118539712, 2010.
3. T.M. Mitchell, *Machine Learning*", (1e), Mc Graw-Hill, New York, ISBN-13: 978-0070428072, 2017.
4. Kevin P. Murphy, *Machine Learning - A Probabilistic Perspective*, MIT Press, ISBN-13: 978-0262018029, 2012.

Department of Mechanical Engineering

Department of Mechanical Engineering runs B.Tech, M.Tech & PhD programs under school of Automobile, Mechanical and Mechatronics (SAMM) since 2011 clubbed and nested under one roof, in order to synergize the commonality. Mechanical Engineering Department embodies the motto of combining classical disciplinary depth and breadth of the courses, together with hands-on experience in labs and internship program in industry to gain experience on live projects. The Department of Mechanical Engineering envision training the students to become industry-ready engineers, capable of tackling challenges of the day; inventing new technologies, procreating new fields of study and becoming leaders in industry, government and academia.

The curriculum of B.Tech program in Mechanical Engineering is designed as per industry need (Make in India) based on "Outcomes Based Education" in the engineering sciences with project-based laboratory and skill based courses to give graduates a strong foundation with impact on employability in design, manufacturing, thermal, industrial and communications skills. The Mechanical Engineering Dept. assist the students to learn the fundamental mechanical concepts through skill based learning in modern academic and research laboratories. Prof. G.L.Sharma is the Director of SAMM and Prof. Rahul Goyal, HoD-Mechanical Engineering. The students have enough opportunities for working on projects and internships in mechanical industries and research institutes to become industry ready engineers. Different students clubs run by student's viz. wings club, innovader club, photography club, ASME chapter, IMechE student's chapter (U.K) organized various activities for students to learn differently foe real industrial world need.

Department of Mechanical Engineering has more than 6 International MoU signed with QS world ranking institutes for students exchange and project /research studies. Students are regularly made to visit industries to learn the technical concepts and to have exposure of manufacturing sector. To have more research oriented, environment for students various research labs viz. BioNach, NICOP, EnBiometric, CLIC centre of excellence has been established and run by Department of Mechanical Engineering.

B.Tech in Mechanical Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH EMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value Ethics & Governance	2	0	0	2	EO2001	Economics	3	0	0	3
	MA2102	Engineering Mathematics-III	2	1	0	3	MA2202	Engineering Mathematics-IV	2	1	0	3
	ME2101	Materials Science and Engineering	3	0	0	3	ME2201	Metrology	3	0	0	3
	ME2102	Kinematics of Machines	2	1	0	3	ME2202	Fluid Mechanics	2	1	0	3
	ME2103	Thermodynamics	3	1	0	4	ME2203	Dynamics of Machines	3	1	0	4
	ME2104	Strength of Materials	3	1	0	4	XXXXXX	Open Elective – I	3	0	0	3
	ME2130	Computer Aided Drafting and Design Lab	0	0	2	1	ME2230	Metrology Lab	0	0	2	1
	ME2131	Strength of Materials Lab	0	0	2	1	ME2231	Fluid Mechanics Lab	0	0	2	1
	ME2170	Seminar	0	0	2	1	ME2232	Computer Aided Numerical Methods	0	0	2	1
							ME2270	Project Based Learning- I	0	0	2	1
			15	4	6	22			17	2	8	23
	Total Contact Hours (L + T + P)		25				Total Contact Hours (L + T + P) + OE		27			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	BB0026	Organization and Management	3	0	0	3	ME3201	Production Technology- II	3	0	0	3
	ME3101	Production Technology- I	4	0	0	4	ME3202	Introduction to Finite Element Methods	3	1	0	4
	ME3102	Design of Machine Elements	3	1	0	4	ME3203	Refrigeration and Air Conditioning	2	1	0	3
	ME3103	Heat & Mass Transfer	3	1	0	4	ME3204	Computer Integrated Manufacturing	3	0	0	3
	ME3104	Internal Combustion Engine	3	0	0	3	ME31XX	Program Elective – I	3	0	0	3
	XXXXXX	Open Elective – II	3	0	0	3	XXXXXX	Open Elective – III	3	0	0	3
	ME3130	Production Technology - I Lab	0	0	2	1	ME3230	Production Technology- II Lab	0	0	2	1
	ME3131	Heat & Mass Transfer Lab	0	0	2	1	ME3231	Refrigeration and Air Conditioning Lab	0	0	2	1
	ME3132	Internal Combustion Engine Lab	0	0	2	1	ME3232	Computer Aided Engineering Lab	0	0	2	1
	ME3170	Project Based Learning- II	0	0	2	1	ME3270	Project Based Learning- III	0	0	2	1
			19	2	8	25			17	2	8	23
	Total Contact Hours (L + T + P) + OE		29				Total Contact Hours (L + T + P) + OE		27			
IV	SEVENTH EMESTER						EIGHTH EMESTER					
	ME41XX	Program Elective – II	3	0	0	3	ME4270	Major Project	0	0	0	12
	ME41XX	Program Elective – III	3	0	0	3						
	ME41XX	Program Elective – IV	3	0	0	3						
	ME41XX	Program Elective – V	3	0	0	3						
	ME41XX	Program Elective – VI	3	0	0	3						
	ME41XX	Program Elective – VII	3	0	0	3						
	ME4170	Minor Project	0	0	2	1						
	ME4171	Industrial Training	0	0	2	1						
			18	0	4	20			0	0	0	12
	Total Contact Hours (L + T + P)		22				Total credits=169(inlduing first year)					

THIRD SEMESTER

BB0025 VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX. Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects. CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B.N. Ghosh, Business Ethics & Corporate Governance, McGraw Hill.
3. S.K. Mandal, Ethics in Business & Corporate Governance, McGraw Hill .
4. C.K. Ray, Corporate Governance, Value & Ethics, Vaya Education of India
5. Abha Chatterjee, Professional Ethics, Oxford Publications.

MA2102: ENGINEERING MATHEMATICS – III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential Equation-Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. S.S. Sastry, *Introductory methods for Numerical Analysis*, (5e), PHI Learning Private Limited, 2012.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
4. R. Spiegel Murray, *Vector Analysis*, Schaum Publishing Co., 1959.

ME2101: MATERIALS SCIENCE AND ENGINEERING [3 0 0 3]

Introduction to Materials Science and Engineering: Materials classification. Crystallography SC, FCC, BCC, HCP structures, APF; Miller indices: Crystal structure Determination-X-ray diffraction techniques, Microscopic examination; Imperfections in Crystals: Point defects, line defects, surface defects. Plastic Deformation of Metals and Alloys, Mechanisms of plastic deformation, role of Dislocation; slip and twinning, grain growth, Solidification of Metals and Alloys: Solid solution, Hume Rothery's rules, Phase diagrams- Phase and Lever Rules relationship of micro Structure and properties, Iron- Carbon equilibrium diagram, Development of microstructure in Iron Carbon alloys, Phase transformation. Mechanical Properties of Metals; Fatigue and Failure of materials: S-N Curve, Fatigue failure. Polymers and applications: Types of polymers, structure and applications; Hydrocarbon and polymer molecules, Molecular weight, shape, structure and configurations, Thermosetting and thermoplastic polymers; Characteristics and Applications of Polymers; Mechanical behavior of polymers, mechanisms of deformation; Crystallization, Melting, and Glass transition phenomena. Application and Properties of Ceramics: Types and applications of ceramics; Ceramic manufacturing; Mechanical and other properties. Fabrication of Plastics, Fibres and Films; Composites Materials: FRP, MMC, PMC and other types and applications; Fibre, Particle reinforced composites, Structural composites; Biocomposites, Nanocomposites, Composite micromechanics. Advanced Materials: Smart materials, Biomaterials, Nanomaterials.

References:

1. W.D. Callister, *Material Science and Engineering*, (2e), Wiley India Pvt. Ltd., 2014.
2. V. Raghavan, *Material Science and Engineering*, (6e), Prentice Hall of India, 2015
3. G.K. Narula and K.S Narula, V.K. Gupta, *Material Science*, (1e), Tata McGraw Hill, 2004.

ME2102: KINEMATICS OF MACHINES [2 1 0 3]

Introduction to mechanisms: kinematic pairs, kinematic diagrams, classification of kinematic chains, kinematic inversions and equivalent linkages. Kinematic analysis of planar mechanisms: mobility analysis and range of movement, Grashof's criteria and inversions, displacement analysis, instantaneous centers, Aronhold-Kennedy theorem, velocity and acceleration analysis. Cams: synthesis of translating flat-face, translating roller follower. Gears: fundamental law of gearing, characteristics of involute action, minimum number of teeth, analysis of gear trains. Introduction to clutch: Uniform pressure and wear theory.

References:

1. A.K. Mallik, A. Ghosh, *Theory of Mechanism and Machines*, (3e), Affiliated East-West Press (P) Ltd., 2015.
2. S.S. Rattan, *Theory of Machines*, (4e), Tata McGraw Hill, 2017.
3. J.E. Shigley, Uicker Jr., *Theory of Machines and Mechanisms*, (4e), McGraw Hill International, 2015.
4. R.L. Norton, *Kinematics and Dynamics of Machinery*, McGraw-Hill Higher Education, 2017.

ME2103: THERMODYNAMICS [3 1 0 4]

Definition and concepts: Heat & Work; Zeroth Law of Thermodynamics; Thermodynamic Properties of Fluids: Mathematical and Graphical representation of data, Ideal gas and Vander Waals Equation of state, Compressibility chart, Mollier diagram, Steam Tables; First law of Thermodynamics: Applications to Non flow and flow processes; Second Law of Thermodynamics: Carnot principle, Absolute thermodynamic temperature scale, Clausius Inequality, Entropy, Calculation of entropy change, Principle of increase-in-Entropy, Entropy generation; Availability: Concept of Available Energy, Availability of closed & open systems, Irreversibility; Thermodynamic Relations: Maxwell relations, Tds relations, Joule-Thompson coefficient, Clausius-Clapeyron equation; Ideal Gas Mixtures: Amagat's and Dalton's model, Properties of ideal gas mixtures, Gibbs phase rule; Gas Power cycles: Air standard cycle- Otto, Diesel, Dual, Stirling, Ericsson, Atkinson and Brayton Cycles; Vapour Power Cycles: Simple Rankine cycle, Reheat and Regenerative cycles with open & closed feed water heater.

References:

1. P.K. Nag, *Engineering Thermodynamics,* (6e), McGraw Hill, 2017.
2. Y.A. Cengel and M A Boles, *Thermodynamics: An Engineering Approach*, (8e), McGraw Hill, 2015.
3. Y.V.C. Rao, *An Introduction to thermodynamics*, (2e), Universities Press (India) Private Limited, 2004.

ME2104: STRENGTH OF MATERIALS [3 1 0 4]

Engineering Statics review. Introduction to deformable body mechanics, Notion of stress and strain – normal and shear stresses and strains, concept of thermal strain and stress. Stress-strain diagram: Mechanical properties. Stress-strain relationship: concept of linear-elastic-isotropic materials and Hook's law. Stress and strain at a point: stress and strain tensors, symmetry of tensors, different state of stresses and strains: uniaxial, biaxial and triaxial. Concept of plane stress and plane strain, stress and strain transformations, Principal stresses and strains. Mohr's circle concept. Deformations in axial loaded members. Bending of beams: shear force and bending moment diagrams, pure bending, normal and shear stresses in beams, deflection in beams. Torsion: torsional moment diagrams, torsion of circular members, maximum normal and shear stresses, angle of twist. Concept of strain energy. Theories of failures. Introduction to energy methods. Elastic stability.

References:

1. F.P. Beer, R.J. Johnson, J. Dewole and D. Mazurek, *Mechanics of Materials*, (7e), McGraw Hill, 2015.
2. S.B. Timoshenko, J.M. Gere J.M, *Mechanics of Materials*, (2e), CBS Publishers, 2006.
3. B.C. Punamia, A.K Jain, *Mechanics of Materials*, Laxmi Publications, 2006.
4. R.K. Bansal, *Strength of Material*, Laxmi Publications, 2007.
5. R.C. Hibbeler, *Mechanics of Material*, Pearson Education, Low Price Edition, 2007.

ME2130: COMPUTER AIDED DRAFTING AND DESIGN LAB [0 0 2 1]

Introduction to design process and drawings of CATIA. Review of sectioning, drawing standards, dimensioning and notes. Fasteners – screws, bolts and nuts. Assembly drawings with sectioning and bill of materials. Assembly of screw jack, plumber block and piston. Detailed part drawings from assembly drawings. Production drawings - limits, fits and tolerances, dimensional and geometric tolerances.

References:

1. K.L. Narayana, *Machine Drawing*, (2e), Wiley Eastern, 2009.
2. C. Jensen, J. Helsel and D. Short, *Engineering Drawing and Design*, (7e), McGraw-Hill Science, 2007.
3. CATIA online web Tutorials.

ME2131: STRENGTH OF MATERIALS LAB [0 0 2 1]

Izod and Charpy Impact testing; Rockwell Hardness Testing; Vicker's Hardness Test; Brinell Hardness Testing; Torsion Testing; Tensile Testing; Compression Testing; Shear Testing; Bending Test on UTM; Measurement of stress due to bending using strain gauges, Study of Fatigue Testing Machine.

References:

1. R. Subramanian, Strength of Material, (2e), Oxford University Press, 2010.
2. A.V.K. Suryanarayan, Testing of Materials, (2e), PHI, 1990.
3. Technical Teachers, Training Institute, Lab Manual of Strength of Materials, Oxford University press, 1983.

ME2170: SEMINAR [0 0 2 1]

Each student has to present a seminar, on any technical topic. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/ question & answers; The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance; Each student has to submit to the department a seminar report at least three days before the day of seminar; Each student has to make the presentation with LCD projector.

FOURTH SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, Macroeconomics Theory and Policy, (20e)S. Chand Publication.
2. H.C. Peterson, Managerial Economics, (9e), 2012.
3. P.L. Mehta, Managerial Economics, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, Engineering Economics, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, Engineering Economics, Tata McGraw Hill.

MA2202: ENGINEERING MATHEMATICS- IV [2 1 0 3]

Special Functions: Series solutions of Bessel and Legendre differential equations, Recurrence formulae, generating functions and Orthogonal properties for Jn(x) and Pn(x). Probability, finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications.

References:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. P. L. Meyer*, Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
4. R.V. Hogg and A.T. Craig, *Introduction to Mathematical Statistics*, (4e), MacMillan, 1975.

ME2201: METROLOGY [3 0 0 3]

Measurements & Measurement Systems: Measuring Standards. Methods of measurement, Static Characteristics of Instruments & measurement systems, Measurement of Pressure by Elastic pressure elements and McLeod gauge., Temperature, Strain, Force, Torque and Shaft work. Limits, Fits and Tolerances: Clearance, Interference and Transition fits, Types of tolerances, System of fits, Principle of interchangeability, Selective assembly approach, Hole basis and Shaft basis system. Gauges: Types of gauges, Taylor's principle for design of gauges. Measurement of Form Errors: Flatness, straightness and squareness measurement, Engineer's Square tester, Optical Square. Comparators. Screw Threads: Design principle and application. Surface Texture measurement: Principles of design and operation. Gear measurement: Gear terminology, Errors in gears, Composite Tooth thickness, Gear tooth Vernier Callipers, Constant chord method, Base tangent method, Geometric Dimension & Tolerances.

References:

1. A.K. Bewoor, V. Kulkarni, Metrology & Measurement, McGraw Hill Publication, 2012.
2. N.V. Raghavendra, L. Krishnamurty, Engineering Metrology & Measurements, Oxford Publications, 2013.
3. R.K. Jain, Engineering Metrology, Khanna Publishers, 1997.
4. A.K. Sawhney, Mechanical Measurement & Instrumentation, Dhanpat Rai & Co, 2002.
5. I.C. Gupta, Engineering Metrology, Dhanpat Rai Publications, 1997.

ME2202: FLUID MECHANICS [2 1 0 3]

Properties of Fluids: Introduction, Various properties, Newtonian and Non-Newtonian Fluids. Fluid Statics: Pressure and its measurement: Pressure gauge, Manometers, Pascal's law, Hydrostatic law: Forces on plane and curved surfaces, Centre of pressure; Buoyancy, equilibrium of submerged and floating bodies, metacentric height. Fluid Kinematics: Lagrangian and Eulerian description of fluid flow, Types of Fluid flow, Stream line, path line and streak lines, Continuity equation, Fluids subjected to Velocity and acceleration, Stream function, Velocity Potential function Fluid Dynamics: Euler's and Bernoulli's equation, Bernoulli's theorem, Applications of Bernoulli's equation Flow: Pipe flow: Darcy Weisback equation, Friction factor, Minor and major losses in pipe, power transmission in pipe flow. Dimensional Analysis: Basic and derived quantities, Similitude and dimensional analysis, Buckingham π – theorem, Non-dimensional parameters and its significance. Boundary layer concept: Boundary layer separation. Viscous flow: Laminar flow: circular pipe (Hagen Poiseuille's equation), Parallel Plates. Introduction to hydraulic machines.

References:

1. Frank M. White, *Fluid Mechanics*, (7e), Tata McGraw Hills Pub.,2011
2. P. N. Modi and Seth, *Fluid Mechanics*, (5e), Standard Book House Pub., 2002.
3. Yunus A. Cengel, John M. Cimbala, *Fluid Mechanics*, (3e), 2014.
4. A. K. Jain, *Fluid Mechanics Including Hydraulic Machines*, (12e), Khanna Publication, 2016
5. R. K. Bansal, *Fluid Mechanics and Hydraulic Machines*, (9e), Laxmi Publications, 2015.

ME2203: DYNAMICS OF MACHINES [3 1 0 4]

Static force analysis; inertia forces, dynamic force analysis, dynamically equivalent system, turning moment diagram, flywheels; working principle of governors, centrifugal governors, characteristics of governors, controlling force curve; principle of gyroscopic couple, stability of plane, ships and vehicles; balancing for rotating and reciprocating machines, balancing of inline engines; introduction to vibration, natural frequency, single degree of freedom- free and forced damped and undamped vibrations.

References:

1. A.K. Mallik, A. Ghosh, *Theory of Mechanism and Machines*, (3e), Affiliated East-West Press (P) Ltd., 2015
2. S.S Rattan, *Theory of machines*, Tata McGraw Hill, 2005.
3. S.S. Rao, *Mechanical vibrations*, (5e), Pearson, 2010.
4. J.E. Shigley, Uicker Jr., *Theory of Machines and Mechanisms*, (4e), McGraw Hill International, 2015.

5. R.L. Norton, *Kinematics and Dynamics of Machinery*, McGraw-Hill Higher Education, 2017.

ME2230: METROLOGY LAB [0 0 2 1]

Study of measuring instruments and gauges; Screw thread measurement using tool maker's microscope; Use of profile projector; Measurement of effective diameter of external screw threads using Screw thread micrometer and floating carriage micrometer; Use of comparators; Gear testing (Parkinson's and Gear roller tester); Radius measurement; Angle measurement; Sine bar; Demonstration of surface roughness measurement; Straightness measurement; Measurement using Interferometer; Temperature measurement using thermocouple.

References:

1. A.K. Bewoor, V. Kulkarni, *Metrology & Measurement*, McGraw Hill Publication, 2012.
2. N.V. Raghavendra, L. Krishnamurty, *Engineering Metrology & Measurements*, Oxford Publications, 2013.
3. R.K. Jain, *Engineering Metrology*, Khanna Publishers, 1997.
4. A.K. Sawhney, *Mechanical Measurement & Instrumentation*, Dhanpat Rai & Co, 2002.
5. I.C. Gupta, *Engineering Metrology*, Dhanpat Rai Publications, 1997.

ME2231: FLUID MECHANICS LAB [0 0 2 1]

Calibration of V- Notch, Calibration of Rectangular Notch, Calibration of Weirs, Determination of discharge through a Venturimeter, Determination of discharge through an Orifice meter, Determination of Friction Factor in flow through pipes, Verification of Bernoulli's principle, Characteristics and performance testing of Reciprocating Pump, Characteristics and performance testing of Multistage Centrifugal Pump, Characteristics and performance testing of Gear Oil Pump Characteristics and performance testing of Pelton Wheel, Characteristics and performance testing of Francis Turbine, Impact of Jet on flat vanes.

References:

1. Frank M. White, Fluid Mechanics, (7e), Tata McGraw Hills Pub.,2011
2. P. N. Modi and Seth, Fluid Mechanics, (5e), Standard Book House Pub., 2002.

ME2232: COMPUTER AIDED NUMERICAL METHODS LAB [0 0 2 1]

Introduction to User Interface of MATLAB, data files and types, basic mathematics operators, operation on matrix, writing and execution of script files, 2D Plots: Basic plotting functions, creation of plot, legends. 3D plots: creating Mesh and surfaces. Programming: flow control, writing functions, Loops and conditional statements, Functions. Symbolic Math in MATLAB: Calculus-numerical differentiation and integration, Matrix Iteration Methods, Eigen value problem, Linear Algebra, Roots of polynomials, Algebraic equations, differential equations, Fourier and Laplace Transforms, MATLAB Simulink.

References:

1. MATLAB User Manual
2. C.C. Steven, *Applied Numerical Methods*, McGraw-Hill, 2008

ME2270: PROJECT BASED LEARNING-I [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

FIFTH SEMESTER

BB0026: Organization and Management [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures,

Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship – Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

References:

1. Koontz, Harold, Cyril O'Donnell and H. Weihrich, *Essentials of Management*, Tata McGraw Hill.
2. Robbins, Stephen P, and Mary Coulter, *Management*, Prentice Hall.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill
5. K. Aswathappa, *Human Resource and Personnnel Management*, Tata McGraw Hill
6. William Wether& Keith Davis, *Human Resource and Personnel Management*, McGraw Hill.

ME3101: PRODUCTION TECHNOLOGY- I [4 0 0 4]

Introduction to Sand Casting, Special Casting Process Shell Mold Casting, Investment Casting, Die casting, Centrifugal Casting, CO2 Molding, Applications-Advantages-Disadvantages of above processes, Defects in casting, causes & remedies. Metal Joining processes: Principles of welding, soldering and brazing. Types of welding processes and welded joints. Heat Affected Zone in Welding, Minimization of HAZ. Metal Forming: Introduction to Metal Forming, Nature of plastic deformation, Hot and cold working, Strain hardening, Recrystallization and grain growth. Rolling: Principle, Types of rolling mills, Roll passes, Forces in rolling and power requirements. Extrusion: Basic extrusion process - Types. Forging: Principles of forging, Tools and dies, Types: Smith forging, Drop Forging, Forging hammers, Rotary forging, Forging defects, causes and remedies, Wire Drawing. Sheet Metal Forming: Spring back effect, Stamping, Blanking, Bending, Drawing, Piercing, Coining, Embossing, Stretch forming. Processing of Plastics: Types of Plastics, Properties and applications, Processing Methods & Equipment (Blow & Injection Molding).

References:

1. S. Kalpakjian and S.R. Schmid, *Manufacturing Engineering and Technology*, (6e), Pearson Education, 2009.
2. A. Ghosh, and A.K. Malik, *Manufacturing Science*, (2e), Affiliated East West Press Pvt. Ltd., 2010.
3. P.C. Sharma, *A text book of Production Technology*, (4e), S. Chand and Company, 2006.
4. R.K. Jain, *Production Technology: Manufacturing Processes, Technology and Automation*, (17e), Khanna Publishers, 2011.

ME3102: DESIGN OF MACHINE ELEMENTS [3 1 0 4]

Design for strength: Review of theories of failures, Static loading, Allowable stress, Factor of safety, Stress concentration factor, curved beam, Design for fluctuating load. Riveted joints: Structural joints of lap & butt types, Rivets joints subjected to eccentric loading. Welded joints: Types of welding joints and symbols, Strength of welded joints and Design principle. Eccentric loading in welded joint. Shafts - ASME code equations for design of transmission shafts, design of shafts subjected to combined load. Design of Flexible Mechanical elements: Introduction, design of flat belt and V- belt. Gear design: introduction, Gear materials, load analysis on gear tooth, Contact Ratio, Stresses on gears. Key and couplings design.

References:

1. J.E. Shigley, C.R. Mischke, *Mechanical Engineering Design*, (7e), McGraw Hill Publication, 2003.
2. R.L. Norton, *Machine Design-An Integrated Approach*, (5e), Pearson Publisher, 2013.
3. U.C. Jindal, *Machine Design*, (1e), Pearson publisher, 2010.
4. V.B. Bhandari, *Machine Design Data book*, McGraw Hill Publication, 2014.

ME3103: HEAT & MASS TRANSFER [3 1 0 4]

Introduction, modes of heat transfer. Conduction, Fourier law, 3-D heat conduction equation, one dimensional steady state heat conduction in simple geometries – plane wall – cylinder and sphere. Critical thickness of insulation,

internal heat generation, heat transfer from extended surfaces, unsteady state heat conduction. Convection: Concept of boundary layer theory, empirical correlation for free & forced convection, laminar and turbulent flow over a flat plate, flow over cylinders, spheres, bank of tubes. Radiation: thermal radiation, laws of radiation, Black and Grey bodies. Shape factor, radiation exchange between surfaces, Radiation shields, Greenhouse effect. Heat exchangers: Classification of heat exchangers, overall heat transfer coefficient, concept of fouling factor, Analysis of heat exchanger by using LMTD and NTU. Boiling and Condensation: pool boiling regimes, critical heat flux, flow boiling correlations, filmwise and dropwise condensation. Mass transfer: Introduction; Fick's law of diffusion, analogy between heat and mass transfer.

References:

1. J.P. Holman, Souvik Bhattacharyya, *Heat Transfer*, (10e), Tata McGraw Hill, 2011.
2. Y.A. Cengel and A J Ghajar, *Heat and Mass Transfer*, (5e), McGraw Hill, 2016
3. F.P. Incropera and D.P. Dewitt, *Fundamentals of Heat and Mass Transfer*, (7e), Wiley, 2012.
4. D S Kumar, *Heat and Mass Transfer*, (9e), Kataria and Sons, 2017.

ME3104: INTERNAL COMBUSTION ENGINE [3 0 0 3]

History of IC engines, Nomenclature, Classification, Comparison. Actual cycles. Testing & Performance, Emission Measurement, Conventional Fuels, Additives. Introduction of Alternative Fuels: Preparation, Engine performance, Combustion in CI & SI engines, Ignition Limits, Stages of combustion, Combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Detonation & knocking, Theories of detonation. Combustion chamber. Engine Systems & Components: Fuel System, Injection systems, Ignition system, engine Friction & Lubrication, engine cooling. Supercharging & Turbocharging. Scavenging, Dual & Multi fuel engines: Principle, fuels, Combustion, performance Advantages, Modification in fuel system. Special Engines: Working principles of Rotary, Stratified charge, Free piston, Variable compression ratio engines.

References:

1. J. B. Heywood, *Introduction to Internal Combustion Engines*, (2e), McGraw Hill Publication, 2018.
2. V . Ganeshan, *Internal Combustion Engine*, (4e), McGraw Hill Publication, 2017.
3. C. Ferguson, *Internal Combustion Engines*, (2e), John Wiley & Sons, 2016.
4. R. Stone, *Introduction to Internal Combustion Engines*, (4e), The McMillan Press, 2012.

ME3130: PRODUCTION TECHNOLOGY - I LAB [0 0 2 1]

Practice of foundry operations, preparation of green sand mold, testing, and casting. Smithy operation and temperature measurement, Experiments on die casting machine and testing using ultrasonic flaw detector. Welding Practice: Preparation of welding joints by gas welding and arc welding, spot welding, TIG and MIG welding.

References:

1. S.K. Chaudhury and S.K. Hajara*, Elements of Workshop Technology Vol.1*, (14e), Media Promoters & Publishers Pvt. Ltd., 2010.
2. B.S. Raghuvanshi, *A course in Workshop Technology Vol.1*, (4e), Dhanpat Rai & Sons, 2014

ME3131: HEAT & MASS TRANSFER LAB [0 0 2 1]

Calibration of thermocouple Thermal conductivity of metal rod; Heat Transfer Through Composite Plane Walls; Heat transfer through Lagged pipe; Thermal conductivity of Insulating Material; Heat Transfer in Pin Fin; Heat Transfer in Force Convection apparatus; Heat Transfer in Natural Convection; Shell and Tube heat Exchanger; Emissivity Apparatus; Stefan Boltzman Apparatus, Critical Flux, Unsteady state heat transfer, Drop and Film Condensation Apparatus

References:

1. M. Thirumaleshwar, *Fundamentals of Heat and Mass Transfer*, (1e), Pearson Publication, 2006.

ME3132: INTERNAL COMBUSTION ENGINE LAB [0 0 2 1]

Cut Sectional 4 Stroke 1 Cylinder Petrol Engine for valve timing diagram; Performance test and Heat balance analysis of 4 stroke 4 cylinder Diesel engine test rig with Electrical dynamometer; Evaluating friction power by Morse test rig; Four Stroke Four Cylinder Petrol Engine Test Rig With Electrical Dynamometer; Performance Test of 4 stroke 3 cylinder petrol engine test rig with (AC dynamometer) with heat balance sheet; Performance test and heat balance analysis of four stroke single cylinder CI engines test rig with DC generator; Performance test and Heat balance

analysis of four stroke single cylinder CI engines test rig with rope brake dynamometer; Performance test and Heat balance analysis of four stroke single cylinder CI engines test rig with hydraulic dynamometer. Fire and flash point tests; calorific value of liquid and gaseous fuel.

References:

1. S. Domukundwar, C.P. Kothandaraman, *A course in Thermal Engineering*, Dhanpath Rai, 2013.
2. P.L. Ballaney, Internal Combustion Engines, (6e), Khanna Publication, 2007.

ME3170: PROJECT BASED LEARNING-II [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SIXTH SEMESTER

ME3201: PRODUCTION TECHNOLOGY- II [3 0 0 3]

Mechanics of Metal Cutting, Methods of Machining, Types of Cutting Tools, Cutting tool materials, cutting fluids, Nomenclature of Single point cutting tool, Types of chips in machining process, Merchant's Theory, Tool wear and Tool life. Lathe: Introduction to Capstan and Turret lathe. Introduction to shaper, Planer & Slotter. Milling: Mechanics of Milling, Types of Milling Machines and Milling Cutters, Types of Milling processes, Concept of Indexing Mechanism/Dividing Head. Hole Making Operations: Mechanics of Drilling, Nomenclature of Twist Drill Bit, Types of Drilling Machines, Estimation of Machining time & Metal removal rate in Drilling operation. Finishing Operations: Mechanics of Grinding Operation, Specifications and Selection of Grinding Wheels. Lapping, Honing and Buffing, Broaching. Economics of metal machining.

References:

1. A. Ghosh, A.K. Malik, *Manufacturing Science*, (2e), Affiliated East West Press Pvt. Ltd., 2010.
2. P.N. Rao, *Manufacturing Technology Volume-2*, (4e), McGraw Hill Publication, 2013
3. S. Kalpajian, and S.R. Schmid, *Manufacturing Engineering and Technology*, (4e), Pearson Publication, 2002.
4. P.C. Sharma, *A text book of production technology*, (4e), S. Chand Publication, 2013.
5. R.K. Jain, *Production technology: Manufacturing Processes and Technology*, (17e), Khanna Publication, 2011.

ME3202: INTRODUCTION TO FINITE ELEMENT METHODS [3 1 0 4]

Introduction to FEM: Historical prospects, Applications, Commercial Software, Review of Matrix Algebra, Theory of Elasticity: Equilibrium equations, Stress-Strain relations, Compatibility equations, Plane stress and plane strain equations. Minimization of functional as solution of governing equations: Variational approach, Potential energy approach, Rayleigh Ritz methods, weak formulations and weighted residual (Galerkin method) methods. One Dimensional Elements: Bars- uniform, varying and Trusses. Beams. Stiffness matrix, force and displacement vectors and governing differential equations for such problems. 2-D element formulation, Constant Strain Triangle (CST) elements, Lagrange's Element formulations, Isoparametric elements.

References:

1. R.D. Cook, D.S. Malkus, M.E. Plesha and R.J. Witt, *Concepts and Applications of Finite Element Analysis*, (4e), 2002.
2. T.R. Chandrupatla, A.D. Belegundu, *Introduction to Finite Elements in Engineering*, (4e), PHI Learning Private Limited, 2011.
3. J.N. Reddy, *An Introduction to the Finite Element Method*, (3e), 2006
4. K.J. Bathe, Finite Element Procedures, (2e), 2007.

ME3203: REFRIGERATION AND AIR CONDITIONING [3 0 0 3]

Introduction to basic refrigeration cycles: Reverse Carnot cycle, Air refrigeration cycles, Air refrigeration cycles for aircrafts, Bell- Coleman cycle. Refrigerants and its properties, Ideal & Actual vapour compression cycle, Compound vapour compression refrigeration system, Multi evaporator and cascade systems, Ammonia absorption refrigeration, Lithium Bromide absorption system, Air Conditioning: Psychrometric properties and charts, Psychrometric of air conditioning process, Human comfort, thermal comfort, factors affecting thermal comfort, Effective temperature, comfort chart, Summer and winter air conditioning, Calculation of heating and cooling loads, Design of air conditioning systems.

References:

1. S.C. Arora and S. Domkundwar, *A Course in Refrigeration and Air-conditioning*, (3e) Dhanpat Rai, 2018.
2. N. Cook, *Refrigeration and Air conditioning*, (5e), Macmillan Education, 1995.
3. P.N. Ananthanarayanan, *Basic Refrigeration and Air conditioning*, (4e), McGraw Hill Education, 2013.
4. Rex Miller, Mark Miller, *Air Conditioning and Refrigeration*, (2e), McGraw Hill Education, 2011.

ME3204: COMPUTER INTEGRATED MANUFACTURING [3 0 0 3]

Introduction to NC machines, DNC Machine, CNC Machine, Part Programming, Maintenance, Economics of machining using CNC machines. Introduction to Computer Integrated Manufacturing Systems [CIMS]: Components, Types of Manufacturing Systems, Group Technology: Classification and Coding Systems. Computer Aided Process Planning: Rotational and prismatic parts, Material Requirement Planning [MRP], Manufacturing Resource Planning [MRP II], Capacity planning, Shop Floor Control, Introduction to FMS: AGV, AS/RS, Co-ordinate Measuring Machines [CMM], Universal Measuring Machine [UMM].

References:

1. K. Yoram, *Computer Control of Manufacturing Systems and Computer Integrated Manufacturing*, McGraw Hill Education, 1983.
2. M.P. Grover, *Automation, Production Systems and computer Integrated manufacturing*, (3e), Pearson International Edition, 2008.
3. Yoram, Ben and U. Joseph, *Numerical Control of Machine Tools*, Khanna Publishers, 2005.
4. P. Radhakrishnan, *Computer Numerical Control Machines*, (2e), New Academic Science Ltd., 2014.

ME3230: PRODUCTION TECHNOLOGY- II LAB [0 0 2 1]

Preparing turning Models by using Lathe. Exercises involving plain turning, step turning, knurling, chamfering, taper turning, facing, free hand turning and "V" & Square thread cutting. Demonstrations on eccentric turning, internal threading, and taper turning by taper turning attachment and tail stock set over method, Capstan and turret lathe etc., Milling Practice: Preparing milling models. Exercises on spur gear, helical gear, bevel gear, Slot milling; Shaping Practice: Preparing Shaping models. Shaping of flat surfaces, inclined surfaces, cutting of slots etc.; Grinding Practice: Exercises on Surface grinding and cylindrical grinding, Demonstrations on various advanced machines and machining operations.

References:

1. S.K. Chaudhury, S.K. Hajara, *Elements of Workshop Technology Vol.1*, (14e), Media Promoters & Publishers Pvt. Ltd., 2010.
2. B.S. Raghuvanshi, *A course in Workshop Technology Vol.2*, Dhanpat Rai & Sons, 2015.

ME3231: REFRIGERATION AND AIR CONDITIONING LAB [0 0 2 1]

Determine the COP and tonnage capacity of VCR test rig, Identification of performance of VCR unit using various types of expansion valve such as capillary expansion valve & thermostatic expansion valve. Performance of vapour absorption refrigeration system and comparison with VCR test rig. Determine the COP and tonnage capacity of Air-conditioner test rig. Study and determination of effectiveness of cooling tower and evaporative cooler, Study of psychrometric chart with different psychrometric process.

References:

1. C.P Arora, *Refrigeration and Air-conditioning*, (2e), McGraw Hill Education, 2006.

ME3232: COMPUTER AIDED ENGINEERING LAB [0 0 2 1]

Introduction to FEA, Demo and Practice of Typical FE Analysis, One-Dimensional Practice Problems, Problem of Stepped Bar, Truss Problems, Simply Supports Beam Problems, Other Beam Problems, Thermal Analysis, Modal Analysis, Additional Problems, Project based Problems, 2 Dimensional Problems and Viva Questions.

References:

1. ANSYS/ABAQUS user manuals
2. D.R. Cook, S.D. Malkus, E.M. Plesha and J.R. Witt, Concepts and Applications of Finite Element Analysis, (4e), 2002.

ME3270: PROJECT BASED LEARNING-III [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SEVENTH SEMESTER

ME4170: MINOR PROJECT [0 0 2 1]

The project work may be carried out in institute laboratory. The duration of the project work shall be 16 weeks. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, as part of project evaluation.

ME4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a period of 4-6 weeks. This may be taken in a phased manner during the vacation starting from the end of sixth semester; the student has to submit to the department a training report in the prescribed format with a power point presentation followed by viva. The report should include the certificates issued by the industry.

EIGHT SEMESTER

ME4270: MAJOR PROJECT [0 0 0 12]

The project work may be carried out in an institution/ industry/ research laboratory. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, before the departmental committee, as part of project evaluation.

PROGRAM ELECTIVES-II, III, IV, V, VI, VII

ME3240: INDUSTRIAL ENGINEERING [3 0 0 3]

Introduction to Industrial Engineering, Scope, importance and applications of industrial engineering. Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, time study, PMTS, determining time, Work sampling. Productivity - Definition, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity. Statistical quality Control (SQC), Variables & Attributes, Production Planning & Control (PPC) : Introduction to Forecasting – Simple, Weighted moving average and exponential smoothing method, Aggregate planning, Master production schedule (MPS), Sequencing - Johnson algorithm for n-Jobs-2 machines, n- Jobs-3 machines, n-Jobs m-machines.

References:

1. S.N. Chary, Production & Operations Management, (4e), McGraw Hill Publication, 2009.

2. E. E. Adam, R. J. Ebert, Production and Operation Management: Concepts, Models, and Behaviour, (5e), Prentice Hall Publishers, 1992.
3. S.S. Buffa, Modern Production Management, (8e), John Wiley Publication, 2007.
4. P. Kumar, Industrial Engineering and Management, (1e), Pearson Publication, New Delhi, 2015.

ME3241: PRODUCTION AND OPERATIONS MANAGEMENT [3 0 0 3]

Introduction to production and operations management. Production and process design: Needs for product design and development, Product selection, modifying the existing products. Forecasting: Concept, Basic elements, Classification, Purpose of sales forecasting, Qualitative and Quantitative techniques of forecasting. Production planning and control: Nature, Types, Elements, strategy and aggregate production planning, production control-Loading and scheduling, Line of balance, Sequencing, Plant location and layout: Types of layout, Methodology of layout planning, Computer aided plant layout.

References:

1. W. J. S. Irwin, *Operation Management*, (9e), McGraw Hill Publication, 2005.
2. S. Paton, B. Clegg, J. Hsuan, and A. Pilkington, *Operations Management*, McGraw Hill Publication, 2011.
3. K. Aswathappa, S. Bhat, *Production and Operations management*, (2e), Himalaya Publication, 2015.

ME3242: PROJECT MANAGEMENT [3 0 0 3]

Introduction & objective of Project Management. Project life cycle, Project management as an integrated approach, Project manager and their attributes. Feasibility study, Estimating project times and costs, Top-down approaches of estimation, Bottom-up approaches of estimation, Hybrid approach of estimation. Risk management process, Contingency planning, Contingency funding and time buffers, Risk response control, change control management, Decision tree analysis, Numerical. Project scheduling: Bar charts and Milestone charts, Elements of network, Development of networks, Work Breakdown Structure (WBS), Critical Path Method, Program Evaluation and Review Technique, Network crashing, CPM updating, Numerical. Project audit and closure: Guidelines for conducting a project audit, Initiating and staffing, Data collection and Analysis, Audit reporting.

References:

1. C. Gray, E. Larson and G. Desai, *Project Management – The Managerial Process*, Tata McGraw Hill Pvt. Ltd., 2013.
2. R. Paneerselvam, P. Senthilkumar, *Project Management*, PHI Learning Pvt. Ltd., New Delhi, 2010.
3. J. Meredith, S. Mantel, *Project Management - A Managerial Approach*, John Wiley & Sons, USA, 2012.
4. N.D. Vohra, *Quantitative Techniques in Management*, New Delhi, 2007.

ME3243: MICROMACHINING [3 0 0 3]

Micromachining, Traditional Micromachining Processes, Materials for micromachining, Advanced Micromachining and Nanofinishing, Abrasive Water Jet Micromachining (AWJMM), Ultrasonic Micromachining (USMM), Abrasive Jet Micromachining (AJMM), Thermoelectric Advanced Micromachining, Electric Discharge Micromachining (EDM), Electric Discharge Grinding (EDG) And Electric Discharge Diamond Grinding (EDDG), Wire Electric Discharge Micromachining, Laser Beam Micromachining, Electron Beam Micromachining. Electrochemical and Chemical Advanced Machining, Chemical Micromachining (ChMM). Wafer bonding- Anodic bonding, Fusion bonding, CVD and PVD processes, Spin coating, Evaporation and Epitaxy, Laser ablation technique. Bulk and Surface Micromachining Techniques, Micromachining Tools.

References:

1. V.K. Jain, *Introduction to Micromachining*, Narosa Publishers,New Delhi, 2010.
2. V.K. Jain, *Advanced Machining Processes*, Allied Publishers Private Limited, New Delhi, 2009.
3. Mojtab Kahrizi, *Micromachining Techniques for Fabrication of Micro and Nano Structures*, Intech, 2012

ME3244: SOLAR ENERGY [3 0 0 3]

Solar Radiation: Basics, instruments for measuring solar radiation, solar radiation geometry, empirical equations, solar radiation on tilted surfaces. Liquid Flat plate Collector: Basic elements, performance analysis, transmissivity, absorptivity, heat transfer coefficients and correlations, collector efficiency and heat removal factors, effects of various parameters, Concentrating Collectors: Type of concentrating collectors and their general characteristics, geometry, heat transfer correlations, tracking requirements, performance analysis. Solar thermal power plants:

Concentration and temperatures, parabolic geometries, paraboloid geometries (dish), heliostats, lay out, central receiver, Component design: Energy balance of components, design process and parameters, thermodynamic basis for receiver design, tube receiver concept. Thermal storage for solar power plants. Thermal Energy Storage: Basic methods, Sensible heat storage – liquids- solids-analysis, latent heat storage, thermo chemical storage, application of thermal storage. Performance analysis of miscellaneous solar applications: Solar Air heaters, solar pond, solar still, solar refrigeration.

References:

1. Soteris A. Kalogirou, *Solar Energy Engineering Processes and Systems*, (2e), Elsevier, 2014.
2. S.P. Sukhatme, *Solar Energy Principle of Thermal Collection and Storage*, (3e), Tata McGraw-Hill, 2015.
3. J. A. Duffie and W. A. Beckman, *Solar Engineering of Thermal Process*, (3e), John Wiley & Sons, 2000.
4. H.P. Garg and J. Prakash, *Solar Energy: Fundamentals and Applications*, (1e), McGraw-Hill, 2000.

ME3245: ADVANCED DESIGN OF MACHINE ELEMENTS [3 0 0 3]

Spring design: introduction and spring materials, design of Helical compression springs for static and fluctuating loads, multi-leaf springs. Design of Clutches, Brakes. Gear design: introduction, Gear manufacturing and Gear materials, design and load analysis of Helical, Bevel and Worm gear system. Rolling contact bearing: Introduction, bearing life, load life relation, reliability, selection of rolling contact bearings, mounting and enclosures. Sliding Contact Bearing: Types of journal bearings and lubrications, materials, hydrodynamic lubrication theory, design and selection of Hydrodynamic bearings. Design of Flexible Mechanical elements: introduction, design of V- belt and chain drives. Cylinders and Pressure vessels, Thin cylinder, Thick cylinder, Compound cylinders.

References:

1. J.E. Shigley, C.R. Mischke, *Mechanical Engineering Design*, (7e), McGraw Hill Publication, 2003.
2. R.L. Norton, *Machine Design-An Integrated Approach*, (5e), Pearson, 2013.
3. U.C. Jindal, *Machine Design,* (1e), Pearson, 2010.
4. V.B. Bhandari, *Machine Design Data book*, McGraw Hill Publication, 2014.
5. R.C. Juvinall, K.M. Marshek, *Machine Component Design*, (6e), Willey India Private Limited, 2017.

ME4140: INDUSTRIAL TRIBOLOGY [3 0 0 3]

Introduction to Tribology, Engineering surfaces, surface contact, adhesion. Causes of friction, friction theory, laws of rolling friction, friction of non-metallic material. Introduction, adhesive wear, abrasive wear, corrosive wear, wear analysis. Importance of lubrication, boundary lubrication, mixed lubrication, full fluid film lubrication, Elasto-hydrodynamic lubrication, types and properties of lubricants, lubricants additives. Fluid mechanics concepts, equation of continuity and motion, Generalized Reynold's equation with compressible and incompressible flow. Rolling contact bearing, sliding contact bearing, gears.

References:

1. G.W. Stachowiak, A.W. Batchelor, *Engineering Tribology*, (3e), Elsevier Inc., 2005.
2. J. Halling, *Principles of Tribology*, The Macmillan Press Ltd, 1975.
3. P. Sahoo, *Engineering Tribology*, PHI, 2005.
4. K.C. Ludema, *Friction, Wear, Lubrication: A textbook in Tribology*, CRC Press, 2010.
5. B. Bhusan*, Introduction to tribology*, (2e), Wiley, 2013.

ME4141: ROBOTICS [3 0 0 3]

Introduction: Definition of Robots, Types of Robots, Degrees of Freedom, Degrees of Movements, Robot Configuration, Definition and factor affecting the Control Resolution, Spatial Resolution, Accuracy and Repeatability; Specification of a robot; MTBF; MTTR; Actuators & Sensors in Robot, Rapid Review of Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Jacobians. Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Examples. Independent Joint Control: Actuator Dynamics, PI/PID Control, Drive-Train Dynamics, Feedforward Control, Multivariable Control: Inverse Dynamics, Passivity-Based Robust and Adaptive control, Robot trajectory planning.

References:

1. Craig, J. John, *Introduction to robotics: mechanics and control*, 3/E. Pearson Education India, 2009.
2. R.K. Mittal, I.J. Nagrath, *Robotics and control*, Tata McGraw-Hill, 2003.
3. Schilling, J. Robert, *Fundamentals of robotics: analysis and control. Vol. 629,* Prentice Hall, 1990.

4. K. Yoram, *Robotics*, McGraw Hill Publications, 1992.

ME4142: COMPUTER AIDED DESIGN [3 0 0 3]

Introduction to CAD, Geometric transformation techniques, Representation of curves, curve fitting techniques, Cubic curves, Beziers and b-splines, Hermite curve, Rational curves\NURBS. Types and representation of surfaces, Analytic surfaces, Synthetic types, Polygon surfaces, Quadric and super quadric surface, Bezier and B-spline surface, Hermite surface, Coon's surface, Blobby objects. Solid Modeling: Constructive solid geometry, Boundary representation, CAD standards, Graphical kernel system (GKS), Data exchange standards for modelling data.

References:

1. Zeid, R. Sivasubramanian, *CAD/CAM Theory and Practice*, Tata McGraw Hill New Delhi, 2009.
2. D.F. Rogers, J.A. Adams, *Mathematical Elements for Computer Graphics*, (2e), Tata McGraw Hill, 2017.
3. D.F. Rogers, J.A. Adams, *Procedural Elements for Computer Graphics*, (2e), McGraw Hill, 1997.
4. I. Zeid, *Mastering CAD/CAM*, (2e), McGraw Hill, 2006.

ME4143: INTRODUCTION TO MICRO ELECTRO MECHANICAL SYSTEMS [3 0 0 3]

Introduction to miniaturization, overview of micro-electromechanical systems, scaling analysis, sand to wafer, wafer level processing: RCA clean, Oxidation, Ion implantation, Physical vapour deposition, chemical vapour deposition, Epitaxy, sol-gel method, spin coating, Photolithography, Etching (Chemical and physical), Deep Reactive Ion Etching, Bulk micromachining, Surface Micromachining, LIGA, Micro sensors: Pressure sensor, gyroscope, accelerometer etc. Micro actuators: Electrostatic micro-comb drives, Piezoelectric, Shape Memory alloys etc., Metrology, Microfluidics, Process Modelling and case studies of process models of micro cantilever, micro hinges, micro pressure sensors, transistors, gates, micro-robots, mechanical packaging of microelectronics, assembly of microsystems, packaging materials, Introduction to COMSOL, Modelling of MEMS using COMSOL, RF MEMS.

References:

1. Tai-Ran Hsu, *MEMS and Micro systems Design and Manufacture*, (1e), Tata McGraw Hill, 2002
2. Nitaigour P. Mahalik, *Micromaufacturing and Nanotechnology*,(1e), Tata McGraw Hill, 2007
3. Marc Madou, *Fundamentals of Microfabrication*, (1e), CRC Press, 2002.
4. Chang Liu, *Foundation of MEMS*, (2e), Pearson Education Inc., 2006
5. G.K. Ananthsuresh, *Micro and Smart Systems*, (1e), Wiley, India, 2010.

ME4144: AUTOMATIC CONTROL ENGINEERING [3 0 0 3]

Concepts: Simple open and closed loop systems, concept of feedback, block diagrams, transfer functions. Representation of Control Components and Systems Representation, System Responses: Damping ratio and natural frequency, First order and second order system response to step input, Ramp input and sinusoidal input, response of a system to external disturbance, Frequency Response: Polar and rectangular plots for the frequency response, graphical view point, System Analysis using logarithmic plots, Bode diagrams: Stability analysis using Bode diagrams, simplified Bode diagrams System Analysis using Root locus Plots, Root Locus plots for simple transfer functions, graphical relationships setting the system gain, system transient response, system frequency response, System compensation, Digital Computer Control, State Space Analysis of Control Systems.

References:

1. K. Ogata, *Modern Control Engineering*, (5e), Pearson Publication, 2015.
2. S.N. Verma, *Automatic Control Systems*, Khanna Publishers, 1990.
3. F.H. Raven, *Automatic Control Engineering*, (5e), McGraw Hill Publication, 2013.

ME4145: COMPUTATIONAL FLUID DYNAMICS [3 0 0 3]

Introduction to CFD: Objectives of the course, motivation, course plan, evaluation method, references, Introduction to models of flow, laws of physics, derivations of Continuity, Momentum and Energy equations in Cartesian coordinate system, Transformation of these equations from Non conservative form to conservative; Initial and boundary conditions: One-way and two-way co-ordinates, Discretization Process- concept and structure, Methods of deriving the discretised equations, Explicit Taylor series expansion, Implementation of boundary conditions, The Four basic rules in control volume formulation. The derivation of the pressure correction equation as Poisson's Pressure equation, Implementation of boundary conditions in CFD. Grid generation using algebraic and partial

differential equations; N-S equations in irregular geometry: transformation of N-S equation in curvilinear coordinate system, non-orthogonal grid.

References:

1. J.D. Anderson Jr., *Computational Fluid Dynamics- The Basics with Applications, (6e)*, International Edition, McGraw Hill, 2017.
2. H.K. Versteeg, W. Malalasekera, *An Introduction to Computational Fluid Dynamics-The Finite Volume Method,* (2e), Longman Scientific & Technical, 2007.
3. K.Muralidhar, T.Sundararajan, *Computational Fluid Flow and Heat Transfer,* (2e), Narosa Publishing House, 2009.
4. B. Andersson, R. Andersson, L. Hakansson, M. Mortensen, R. Sudiyo, B. V. Wechen, *Computational Fluid Dynamics for Engineers,* (1e), Cambridge Press, 2011.

ME4146: POWER PLANT ENGINEERING [3 0 0 3]

Concept and types of Power plant, Site selection, Steam Generators, Mountings and Accessories, Steam and heat rate, Steam turbine, Steam power plant, Rankine cycle improvisation, Layout, Components, Coal and ash handling systems, Draught system, Feed water system, Combined cycles power generation and Cogeneration systems. Diesel and Gas Turbine Plant: Components. Nuclear Power Plants: Location, Components of nuclear plants, types of Reactors, Uranium Enrichment, Safety, Disposal of nuclear waste, Comparison with thermal power plants, Safety measures for nuclear power plants. Hydro-electric power plant: Classification, Components and auxiliaries. Major hydro plants in India. Power plant economics, Power tariff types, Load distribution parameters, Load curves. Pollution control.

References:

1. P.K. Nag, *Power Plant Engineering*, (5e), McGraw Hill, 2018.
2. S. Domkundwar, *Power plant Engineering*, (8e), Dhanpat Rai, 2016.
3. M.M. El-Wakil, *Power Plant Technology*, (1e), McGraw Hill Education, 2002.

ME4147: NONCONVENTIONAL MANUFACTURING PROCESS [3 0 0 3]

Rapid Prototyping (RP): Subtractive and Additive Processes, Fused Deposition Modeling, Stereo lithography, laminated object manufacturing and three dimensional printing. Advanced Casting Processes, Advance Welding Processes. Process principles, equipment, applications, advantages and disadvantages of Abrasive Jet Machining (AJM), Water Jet Machining (WJM). Abrasive Water Jet Machining (AWJM), Ultrasonic Machining (USM). Electro Chemical Machining (ECM) Electro Chemical Grinding, Shaped Tube Electrolytic Machining (STEM), Electrical Discharge Machining (EDM), Wire EDM, Electrical Discharge Grinding (EDG), Chemical Machining (CHM), Photo chemical machining. Laser Beam Machining (LBM), Plasma Arc Cutting (PAC), Electron Beam Machining (EBM), Ion Beam Machining (IBM) and Thermal Energy Method (TEM). Introduction to Hybrid and Micro Machining Processes.

References:

1. G.F. Benedict, *Non Traditional Machining Techniques*, Marcel Decker, 1990.
2. E.J. Weller, *Non-Traditional Machining*, Society of Manufacturing Engineers, Dearborn, 1984.
3. P.K. Mishra, *Non-Conventional Machining*, Narosa Publishing.
4. K. Cooper, *Rapid Prototyping Technology: Selection and Application (Mechanical Engineering)*, (1e), CRC Press, 2001.
5. A.K. Kamrani, E.A.Nasr, *Engineering Design and Rapid Prototyping*, Springer, Boston, 2010.

ME4148: HEAT TREATMENT [3 0 0 3]

Iron carbon phase diagram, Time temperature transformation (TTT) and Continuous cooling transformation (CCT) diagram, Characterization of various microstructures. Introduction: Heat Treatment Processes: Annealing- its types and effect on mechanical properties, Hardening, Quenching, Tempering, Surface hardening techniques: flame hardening, induction hardening, laser beam hardening, electron beam hardening, Carburizing and its types, Nitriding, Ionitriding, Ion-carburizing, carbo-nitriding, plasma nitriding, Boronizing & Chromizing, Hardenability,. Elements of heat treatment process including heating rate determination and characteristics of heat treating furnaces, finishing operations, Heat treatment of tools, Heat treatment used to increase strength, Heat treatment and application of Non-ferrous metals and alloys.

References:

1. T.V. Rajan, C.P. Sharma and A. Sharma, *Heat treatment principles and techniques*, (2e), Prentice Hall Publishers, 2010.
2. W. Bolton, *Engineering materials technology*, (3e), Heinmann Newness, 2001.
3. B. Zakharov, *Heat treatment of Metals*, (1e), Mir Publishers, 2002.
4. K.E. Thelning, *Steel and its heat treatment*, (2e), Oxford Publication, 2013.
5. R.C. Sharma, *Principles of Heat Treatment of Steels*, New Age International (P) Limited, 2010.

ME4149: TOOL ENGINEERING [3 0 0 3]

Fundamental of Tool design practice, procedure of tool design, Nomenclature systems of single point cutting tools Design of single point cutting tools, design of milling cutters, gear milling cutters, hobs gear shaping tools, broaches, drill bits, reamers, taps & dies for thread cutting, boring tools, flat form tools, circular form tools. Essential requirements of jigs & fixtures, economics of jigs and fixtures, principles of location and clamping, location and clamping devices, types of drill bushes, types of jigs and fixtures- such as fixtures for milling, welding, heat treatment, grinding, assembly and inspection processes; standardization in jigs and fixtures, principle of work holders, common work holders for production like vice, chuck, arbor, mandrel & collet.

References:

1. B.L. Juneja, G.S. Sekhon, *Fundamentals of Metal Cutting and Machine Tools*, New Age International (P) Ltd., 1995.
2. Shaw M. C., *Metal Cutting Principles*, Clarendon Press, Oxford, 1996.
3. G.R. Nagpal, *Tool Engineering & Design*, Khanna Publishers, 2013.
4. P.H. Joshi, *Jigs and Fixture*, Wheeler Publishing, 1996

ME4150: OPERATION RESEARCH [3 0 0 3]

Classification of optimization, design vector and constraints, objective function, Classical Optimization Techniques: Single variable, and multi-variable optimization, direct substitution method, Linear Programming: Statement of an LP problem, graphical, simplex, Transportation method, Assignment Method. Job sequencing method, Theories of Decision Making, Queuing, Game Theory. Network Models: Critical Path Method, Project Evaluation and Review Technique (PERT). Introduction to Non-linear Programming.

References:

1. S.S. Rao, *Engineering Optimization: Theory and Practice,* (3e), New Age International Publishers, 2013.
2. H.A Taha, *Operations Research; An Introduction*, (9e), Pearson Publication, 2014.
3. K. Deb, *Optimization for Engineering Design Algorithms and Examples*, (2e), Prentice Hall Publishers, 2012.
4. J.C Pant*, Introduction to Optimization techniques*, (7e), Jain Brothers, 2008.

ME4151: DESIGN OF MECHANISM [3 0 0 3]

Introduction to kinematics and mechanisms: Motion, The Four-Bar Linkage, Relative Motion, Kinematic Diagrams, Six-Bar Chains, Degrees of Freedom, Analysis versus Synthesis. Introduction to kinematic synthesis: Graphical and linear analytical methods: Introduction, Tasks of Kinematic Synthesis, Type Synthesis, Tools of Dimensional Synthesis, Prescribed Positions. Graphical Synthesis: Motion Generation: Three Prescribed Positions, Graphical Synthesis for Path Generation: Three Prescribed Positions, Path Generation with Prescribed Timing: Three Prescribed Positions Graphical Synthesis for Path Generation (without Prescribed Timing): Four Positions Function Generator: Three Precision Points. Analytical Synthesis: The Standard Dyad Form, Number of Prescribed Positions versus Number of Free Choices, Three Prescribed Positions for Motion, Path. And Function Generation, Three-Precision-Point Synthesis Examples, Circle-Point and Centre-Point Circles.

References:

1. R.L. Norton, *Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines*, (5e), McGraw Hill, 2011.
2. A.G. Erdman, G.N. Sandor and S. Kota, *Mechanism Design: Analysis and Synthesis*, (4e), Pearson, 2001.
3. K.J. Waldron, G.L. Kinzel, *Kinematic, Dynamics, and Design of Machinery*, (2e), Wiley and Sons, 2004.

ME4152: ELECTRIC VEHICLE TECHNOLOGY [3 0 0 3]

Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid

Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor, Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges, Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Simulations and case studies in above mentioned areas.

References:

1. A. Emadi, J. Miller, M. Ehsani, *Vehicular Electric Power Systems*, CRC Press, 2003.
2. I. Husain, *Electric and Hybrid Vehicles*, CRC Press, 2010.
3. Larminie, James, and John Lowry, *Electric Vehicle Technology Explained*, John Wiley and Sons, 2012.
4. Tariq Muneer, Irene Illescas García, *The automobile, In Electric Vehicles: Prospects and Challenges*, Elsevier, 2017.
5. Sheldon S. Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*, Springer, 2013.

ME4153: ELEMENTS OF MECHATRONICS SYSTEMS [3 0 0 3]

Introduction of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors and Transducers: Displacement Sensor, Strain gauges, Force/Torque, Motion & Velocity sensors, Proximity and Range sensors, ultrasonic sensor, Light sensors, Flow sensors, tactile sensors, Drives and Actuators: relays, DC motor, Servo motor, BLDC Motor, stepper motors, Hydraulic & Pneumatic actuators, Data Acquisition & Translation: Signal conditioning, Multiplexer, Pulse width Modulation, Linearization of data, Signal Averaging, Data Presentation System: Display - oscilloscope, LCD, Printers, Magnetic Recording. Controllers and Algorithms: PID controller.

References:

1. D.G. Alciatore, M.B. Histand, *Introduction to Mechatronics and Measurement systems*, (4e), McGraw-Hill Education, 2011.
2. W. Boltan, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, (4e), Pearson Education, 2010.
3. Devdas Shetty & Richard Kolk, *Mechatronics System Design*, (2e), Cengage Learning, 2010.
4. Dan Nesculescu, *Mechatronics*, (1e), Pearson Education Pvt. Ltd, 2002.
5. D.A. Bradley, *Mechatronics: Electronics in Products and Processes*, (2e), Nelson Thornes, 2004.

ME4154: NON-CONVENTIONAL ENERGY SYSTEMS [3 0 0 3]

Introduction: Different forms, Sources, Need for renewable energy sources, Solar energy: Solar radiation at the earth's surface, Measurement of solar radiation, solar radiation geometry. Solar air heaters, Cooking, Drying, Distillation, Space heating, Refrigeration, Power generation: Low, medium and high temperature cycle, Wind power: Total and maximum power (Betz theory), Actual power, Types of windmill, Wind turbine operation, Forces on the blades and thrust on turbines, Biomass: Types of biomass, Biogas production from organic waste by an aerobic fermentation, Conversion of energy: Thermal, chemical and electromagnetic energy into electricity, Introduction to Energy Storage. Miscellaneous sources of
Non-conventional energy.

References:

1. S. P. Sukhatme, J.P. Nayak, *Solar Energy: Principles of Thermal Collection and Storage,* (3e), McGraw Hill India, 2009.
2. G.D. Rai, *Non-conventional Energy Sources,* (3e), Khanna Publications, 2004.
3. B. H. Khan, *Non-Conventional Energy Resources,* (3e), McGraw Hill Publications, 2017
4. S. Rao, B.B. Parulekar, *Energy Technology*, Khanna Publishers, 2004.

ME4155: ENERGY CONSERVATION, AUDIT AND MANAGEMENT [3 0 0 3]

Energy Conservation: Energy Scenario, Thermodynamic basis of energy conservation, Energy Conservation Act and policies, Energy conservation in HVAC systems and thermal power plants, Energy conservation in buildings and star ratings. Energy Audit: Definition, Energy audit-need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy audit instruments. Energy Management: Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy; Financial Analysis: Simple Payback, IRR, NPV, Discounted Cash flow.

References:

1. C.B. Smith, K.E. Parmenter, *Energy Management Principles*, (2e), Elsevier, 2015.
2. Albert Thumann, William J. Younger, *Handbook of Energy Audits*, (6e), The Fairmont Press Inc., 2003.
3. Frank Krieth, D. Yogi Goswami, *Energy Management and Conservation Handbook*, CRC Press, 2008.

ME4156: COMPOSITE MATERIALS [3 0 0 3]

Introduction to composite materials, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepregs, sandwich construction, Reinforcing fibres-Natural fibres, boron, carbon, ceramic glass, aramids, etc. Short and continuous fibre reinforced composites. Particulate fillers-importance of particle shape and size, Matrix resins-thermoplastics and thermosetting matrix resins. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites, Fabrication techniques pultrusion, filament winding, prepreg technology, injection and compression moulding, resin transfer moulding, reaction injection moulding etc. Biocomposites, Nanocomposites, Micromechanics of composites. Properties and performance of composites. Applications, Mechanisms of fracture in composites, Property evaluation and NDT of composites.

References:

1. M. Schwartz, *Composite Materials handbook*, (2e), McGraw Hill Publication, 1992.
2. A.K. Kaw, *Mechanics of composite materials*, (2e), Taylor & Francis-India, 2010.
3. K.K. Chawla, *Composite material science and Engineering*, (3e), Springer, 2012.

ME4157: MATERIALS MANAGEMENT [3 0 0 3]

Concepts, evolution, importance and scope of materials management, organizational structure, man power planning, functions of management, principles of organisation, motivation, factors and techniques of materials planning & budgeting and budgetary control, purchasing, purchasing policy, purchasing parameters and purchasing procedures. Strategic materials planning, JIT production planning, strategic materials planning, Criteria for make or buy decision, spare parts management including equipment selection, codification and standardization. Capital equipment planning and capital equipment decision and purchase of capital equipment's.

References:

1. S.C. Sharma, *Materials Management and Materials Handling*, Khanna Publishers, 2000
2. J.R.T. Arnold, S.N. Chapman and R.V. Ramakrishnan, *Introduction to Materials Management*, (5e), Pearson Education India, 2011
3. P. Gopalakrishnan, M. Sundareshan, *Material Management*, PHI Publications, 1999.
4. K. Datta, *Materials Management: Procedures, Text and Cases,* (2e), PHI Learning, 2008
5. A.K. Chitale, R.C. Gupta, *Materials management: Text and cases*, PHI Learning, 2013.

ME4158: SUPPLY CHAIN MANAGEMENT [3 0 0 3]

Introduction and objectives of supply chain, Decision phases in a supply chain, Purchasing tools and techniques, Value analysis, Project planning and control techniques, Pricing and revenue management, Costing fundamentals, Types of costing, Managing inventory in a supply chain, Economic order quantity, EOQ determination with instantaneous delivery and without shortages, Effect of quantity discount, safety stock, reorder level & lead time. Facility decisions in supply chain:, Factors influencing network design in supply chain, Models for facility location and capacity allocation, Transportation decisions in a supply chain, Routing and scheduling in transportation, Multistage transportation problems, Truck allocation problem, Travelling salesman problem, Vehicle routing problems, Financial evaluation of supply chain Decisions, The impact of financial factors on supply chain decisions, Discounted cash flow analysis, Evaluating supply chain decisions using decision trees.

References:

1. Chopra and Meindl, *Supply Chain Management – Strategy, Planning and Operation*, (3e), Pearson Education, 2009.
2. Raghuram and Rangaraj, *Logistics and Supply Chain Management: Cases and Concepts*, Macmillan, New Delhi, 2000.
3. Simchi-Levi and Kaminski, *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*, McGraw-Hill, 2003.
4. J. Shapiro, *Modelling the Supply Chain*, Duxbury Thomson Learning, 2009.
5. L.J. Krajewski and L.P. Ritzman, *Operations Management*, Pearson Education (Singapore) Pte. Ltd., 2005.

ME4159: PIPE SYSTEMS ENGINEERING [3 0 0 3]

Introduction: Definition and scope, Importance advantages of transport by pipeline, Piping elements. Codes and standards: ASME codes, Materials of construction, Pipe sizes. Single phase incompressible flow: Flow regimes, Development of velocity profile, Pressure drop calculations, Bernoulli's equation, Major and minor losses, Hydraulic and energy grade lines. Pipe networks: Pipe hydraulics and sizing, Pump and pipe system matching, H-Q curves, Pipes in series and parallel, Pipe network analysis. Structural design of pipe lines: Stress due to internal fluid pressure, Stress due to external fluid pressure, High/low pressure pipes. Planning and construction of pipelines: Piping drawing basics, Development of plot plan, Process piping layout, Utility piping layout, Selection of supports & expansion joints, Flexibility analysis. Protection of pipelines: Pipeline damage due to corrosion, abrasion, heating and freezing, Protection methods - Lining, coating, insulation, jacketing etc. Industrial pipelines: Non-Newtonian fluid flow, Single phase compressible flows - Flow analysis for ideal gas, flow analysis for real gas, Multi-phase flows – Slurry pipelines, Pneumotransport, Capsule pipelines.

References:

1. H. Liu, *Pipeline Engineering*, Lewis Publishers, CRC Press LLC, 2003.
2. G.A. Antaki, *Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair,* CRC Press, 2003.
3. B.E. Larock, R.W. Jeppson and G.Z. Watters, *Hydraulics of Pipeline Systems*, CRC Press LLC, 2000.
4. M.L. Nayyar, *Piping Handbook*, McGraw-Hill, 2000.

ME4160: ARTIFICIAL INTELLIGENCE & MACHINE LEARNING [3 0 0 3]

Introduction to Artificial intelligence and intelligent agents. Solving Problems by Searching, heuristic search techniques, constraint satisfaction problems, stochastic search methods. Game Playing: min-max, alpha-beta pruning. Propositional logic, first order logic, Uncertain Knowledge and Reasoning. Introduction to Machine Learning, Linear Regression and Feature Selection, Linear Classification, Support Vector Machines and Artificial Neural Networks, Bayesian Learning and Decision Trees, Clustering, Reinforcement Learning.

References:

1. Tom M. Mitchell, *Machine Learning*, (1e), McGraw Hill Education, 2017.
2. S.J. Russell, P. Norvig, *Artificial Intelligence: A Modern Approach*, (3e), Pearson Education India, 2015.
3. D.W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, (1e), Pearson Education India, 2015.
4. Yuxi (Hayden) Liu, *Python: Machine Learning by example*, (1e), Packt Publishing Limited, 2017.
5. P. Joshi, *Artificial Intelligence with Python*, (1e), Packt Publishing Limited, 2017

ME4161: PLANT LAYOUT AND MATERIAL HANDLING [3 0 0 3]

Principle of plant layout, product, process and combination layout, economics of different types of layout. Factors influencing the layout manpower, movement, service, material, machinery, waiting, building and change factors, location of storages & delay point. Layout planning scientific approach, flow process chart, cross chart, string diagram, line balancing, templates evaluation of layout, installation of layout, computerized layout planning. Material handling- principles of material handling, factors in selection of material handling equipment, safety in material handling, types of material handling equipment, modern material handling equipment.

References:

1. E.S. Buffa, S.K. Rakesh, *Modern Production and Operation Management*, John Wiley & Sons, 2003.
2. M. Richard, *Practical Plant Layout*, McGraw-Hill, 1955.
3. A.M. James, *Plant Layout and Material Handling*, John Wiley, New York, 1977.

ME4162: LEAN MANUFACTURING [3 0 0 3]

The production system, types, inception &necessity of lean production system, lean revolution in Toyota, basic image of lean production, Principles& Characteristics of Lean Manufacturing, MUDA(waste) and types, Lean Manufacturing Tools and Techniques, Cellular Manufacturing, Continuous Improvement, Just-In-Time, Production Smoothing, Overall Equipment Efficiency, standardized work and KAIZEN, Standardization of operations, Multi-function workers and job rotation, Improvement activities to reduce work force and increase worker morale foundation for improvements, Shortening of production lead times.

References:

1. L. Wilson, *How to implement Lean Manufacturing*, The McGraw Hill Companies, 2010.
2. W.M. Feld, *Lean Manufacturing Tools, Techniques, and How To Use Them*, CRC Press, 2000.
3. J.P. Womack, D.T. Jones and D. Roos. D, *The Machine that changed the World. The Story of Lean Production*, Harper Perennial, 2007.
4. N. Gopalakrishnan, *Simplified Lean Manufacture Elements, Rules, Tools and Implementation*, PHI,2010.

ME4163: PRODUCTION PLANNING AND CONTROL [3 0 0 3]

Introduction: Functions of production, planning and control. Types of production activities, Production consumption cycle. Forecasting Analysis: Importance and uses of forecasting, Type of forecasts, Qualitative methods of forecasting, Quantitative methods of forecasting, Exponential smoothing, Linear regression analysis, Correlation analysis and Seasonality, Forecast control. Aggregate planning: Need and inputs for aggregate production planning, Pure and mixed strategies of aggregate planning. Aggregate planning approach. Job shop scheduling: Factors affecting job shop scheduling, Index method, Priority sequencing rules, Determination of mean flow time, average job lateness and average number of jobs in the system. Inventory control: Classification of inventories, Economic order quantity, Inventory control models, Effect of quantity discount, Safety stock, Reorder level, Lead time. MRP: Product structure tree, MRP inputs and outputs, MRP logic, Problems. Assembly line balancing.

References:

1. G.M. Joseph, *Operations Management*, Tata McGraw-Hill Publishing Co. Ltd., 2004.
2. L.J. Krajewski, P.L. Ritzman, *Operations Management*, Pearson Education (Singapore) Pte. Ltd., 2005.
3. E.E. Adam, R.J. Ebert, *Production and Operations Management*, Prentice Hall of India Pvt. Ltd., 2002.
4. R.B. Chase, N.J. Aquilano and F.R. Jacobs, *Production and Operations Management*, Tata McGraw-Hill Publishing Co. Ltd., 1999.
5. Eilon Samuel, *Elements of Production Planning and Control*, Universal Publishing Corporation, 1991.

ME4164: THERMAL STORAGE SYSTEMS AND ITS APPLICATIONS [3 0 0 3]

Thermal energy storage: principles and applications, sensible and latent heat storage systems, Sensible heating systems: Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; `Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage. Latent heat storage systems: Phase Change Materials (PCMs); Selection criteria of PCMs; Stefen problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process. Energy and exergy analysis of thermal energy storage systems case studies. Applications: Active and passive thermal energy storage, Solar water/air heater, crop dryer, building space comfort.

References:

1. I. Dincer, M.A. Rosen, *Thermal Energy Storage Systems and Applications*, (2e), John Wiley & Sons Ltd, 2011.
2. S.P. Sukhatme, J.P. Nayak, *Solar Energy: Principles of Thermal Collection and Storage,* (3e), McGraw Hill India, 2009.
3. L.F. Cabeza, *Advances in Thermal Energy Storage Systems: Methods and Applications,* (1e), Woodhead Publishing Seriesin Energy, Elsevier Science and Technology, 2014.
4. H. Mehling, L.F. Cabeza, *Heat and cold storage with PCM-An up to date introduction into basics and applications,* (1e), Berlin Springer, 2008.

ME4165: ALTERNATIVE FUELS IN I.C. ENGINES [3 0 0 3]

Introduction: Need of alternative gaseous fuels, future automotive gaseous fuels, hydrogen, CNG, LNG, and Producer gas, biogas, LPG. Physical properties of different gaseous fuels, mode of engine operations, spark ignition and dual fuel mode, multi fuel mode, combustion and performance of engines, specific problems. Use of alcohol in four stroke S I & C I engines, use of alcohol in two stroke engines, use of bio diesels, combustion and performance of engines. Impact of alternative fuels on engine test, guidelines for emission measurements, emission norms for engines using alternative fuels. Legal aspects of blending alternative fuels into conventional liquid fuels, properties of blends, comparison of neat versus blended fuels, fuel testing.

References:

1. J. B. Heywood, *Introduction to Internal Combustion Engines*, McGraw Hill Publication, 2011.
2. V. Ganeshan, *Internal Combustion Engine*, (4e), McGraw Hill Publication, 2012.
3. C. Ferguson, *Internal Combustion Engines*, (2e), John Wiley Publication, 2016.
4. R. Stone, *Introduction to Internal Combustion Engines*, (4e), McMillan Press, 2012.

ME4166: TURBOMACHINERY [3 0 0 3]

Basic Principles of Turbomachines; Classification, Energy Transfer in Fluid Machines, Euler's equation, Impulse and Reaction machines, Velocity triangles for radial and axial flow turbomachines. Centrifugal Gas Turbine; Thermodynamic Analysis. Various components of Gas Turbine and Propulsion systems, Cascade Theory, Axial Flow Turbine; Degree of Reaction, Calculation of Stage Efficiency and Turbine Performance. Gas Turbine Combustors, Steam Turbines, Flow through nozzles, Stagnation properties, sonic properties and isentropic expansion through nozzles, Isentropic Flow, Single-Stage Impulse Turbine, Compounding of the Impulse Turbine, Reaction Turbines, Stage Efficiency and Reheat factor. Centrifugal Compressor; Power input factor, Losses in Centrifugal Compressors, Compressor characteristics. Axial Flow Compressors; Surging and stalling of compressors, Compressor characteristics, Reciprocating compressors; principle and applications. Hydraulic Turbines; Pelton Wheel, Specific Speed, Governing, Limitation, Kaplan Turbine, Francis Turbine, Types of Draft Tubes, Cavitation, and Performance Characteristics, Comparison of Specific Speeds of Hydraulic Turbines. Hydraulic pumps.

References:

1. S. Dixon, *Fluid Mechanics and Thermodynamics of Turbomachinery*, (7e), Butterworth-Heinemann, 2014
2. S. M. Yahya, *Turbines, Compressors & Fans*, (2e), Tata-McGraw Hill Co., 2002.
3. P. W. William, *Fundamentals of Turbomachinery*, (1e), John Wiley & Sons, 2008.
4. M. S. Govindgouda, A. M.Nagaraj, *A Text book of Turbomechanics*, (4e), M.M. Publications, 2008.
5. B. K. Venkanna, *Fundamentals of Turbomachinery*, PHI, 2009.

ME4167: INTRODUCTION TO THEORY OF ELASTICITY [3 0 0 3]

Definition and Notation: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions. Two Dimensional Problems: Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure. General equations in cylindrical co-ordinates: Thick cylinder under uniform internal and / or external pressure. Stresses in an Infinite Plate: Stresses in an Infinite Plate (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration. Torsion of Circular, Elliptical and Triangular Bars: Membrane analogy, torsion of thin open sections and thin tubes. Uniqueness Theorem: Principle of super position, reciprocal theorem, Saint Venant principle.

References:

1. M.H. Sadd, *Elasticity: Theory, Applications and Numerics*, (2e), Academic Press, 2009.
2. S. Timoshenko, J.N. Goodier, *Theory of Elasticity*, (3e), Tata McGraw Hill, 2017.

ME4168: INTRODUCTION TO FRACTURE MECHANICS [3 0 0 3]

Introduction: Historical perspective, Stress concentration effects of flaws, Fracture Mechanics approach to design, Effect of material properties on fracture, Damage tolerance. Linear Elastic Fracture Mechanics (LEFM): An atomic view of fracture, Stress concentration effect of flaws, Mathematical foundation of LEFM, The Griffith energy balance, The energy release rate, The path independent, J-, L-, and M-integrals, The Westergaard stress function, Stress analysis of cracks, The stress intensity factor, Relationship between K and G, Crack Tip Plasticity, The Irwin's

approach, The strip yield model, comparison of plastic zone correction, Plane stress vs Plane strain, K as a failure criterion, Effect of loading mode and specimen dimension. Introduction to Fracture Toughness Testing.

References:

1. T.L. Anderson, *Fracture Mechanics: Fundamentals and Applications,* (4e), CRC Press, 2017.
2. E.E. Gdoutos, *Fracture Mechanics: An Introduction*, (2e), Springer, 2006.

ME4169: MECHANICAL VIBRATION [3 0 0 3]

Introduction of Vibration: Types of Vibration, Single degree freedom system. Two-DOF Free Vibrations: Generalized and Principal coordinates, derivation of equations of motion, Lagrange's equation, Coordinate coupling. Multi-DOF: Influence coefficient method, Modal analysis: Undamped and damped, Matrix iteration method, Dunkerley's method. Torsional vibration: Holzer method and Geared system. Continuous systems: Vibration of strings, Longitudinal and torsional vibration of rods, Transverse vibration of beams. Finite element analysis: Finite element formulation for rods, Finite element formulation for beams, Modal Analysis with FEA

References:

1. S.S. Rao, *Mechanical Vibration*, (4e), Pearson Education, 2004.
2. W.T. Thomson, *Theory of Vibrations with Applications*, (5e), Pearson Education, 2008.
3. L. Meirovitch, *Elements of Vibration analysis*, McGraw-Hill, Singapore, 1986.

OPEN ELECTIVES

ME2080: INTRODUCTION TO NANOTECHNOLOGY [3 0 0 3]

Basic concepts of Nanoscience and Nanotechnology; Nanostructures and different types of Nanomaterials: Basic structure of nanoparticles- kinetics in nanostructured materials- zero dimensional, size and shape of nanoparticles; one-dimensional and two dimensional nanostructures- clusters of metals, nanowires, semiconducting nanoparticles and bionano-particles. Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; metal nanocrystals by reduction, sol-gel synthesis, microemulsions or reverse micelles, myle formation, solvothermal synthesis, thermolysis routes, microwave heating synthesis, sonochemical synthesis, electrochemical synthesis, photochemical synthesis, synthesis in supercritical fluids. Fabrication of Nanomaterials by Physical Methods: Inert gas condensation, arc discharge, plasma arc technique, RF plasma, MW plasma, ion sputtering, laser ablation, laser pyrolysis, ball milling, molecular beam epitaxy, chemical vapour deposition method and electro deposition. Nanocomposites: An introduction: types of nanocomposite (i.e. metal oxide, ceramic, glass and polymer based), core-shell structured nanocomposites, superhard nanocomposite, Synthesis, applications and milestones. Characterizing Nanoparticles Analytical Technique; Toxicity and Safety of Nanomaterials: Environmental concerns of nanomaterials. Applications of Nanotechnology: Nanotechnology in medicine; nanotechnology for food, agriculture, livestock, aquaculture and forestry, nanotechnology for a sustainable environment.

References:

1. G.C.Y. Wane, *Nanostructures and Nanomaterials*, (2e), World Scientific Publishing, 2011.
2. C.P. Poole, F.J. Owens, *Introduction to Nanotechnology*, (1e), wiley india Pvt. Ltd, 2007.
3. T. Pradeep, *Nano: The essentials*, (1e), McGraw Hill Professional, 2008.
4. R. Kelsall, *Nanoscale Science and Technology*, (1e), John wiley & sons, 2005.
5. A.S. Edelstein and R.C. Cammarata, *Nanomaterials: Synthesis, properties and applications*, (1e), Institute of Physics, 1996.

ME2081: INTRODUCTION TO QUALITY CONTROL [3 0 0 3]

Definitions of the term quality, Patterns of variation, Causes of variation Frequency distribution, Measures of central tendency and dispersion, The Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables (X , R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes, Control charts for attributes (p ,np, c and u charts), Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, Acceptable quality level, Lot tolerance percent defective, Average outgoing quality, Average total Inspection, Average fraction inspected, Producers risk, Consumers risk, Acceptance sampling tables, Conventional and Statistical tolerancing, Precision, Accuracy and Reproducibility of method of measurements, Quality costs.

References:

1. E.L. Grant, R. Levenworth, *Statistical Quality Control*, McGraw Hill Publications, 2005.
2. M.S. Mahajan, *Statistical Quality Control*, Dhanpat Rai and Co. Pvt. Ltd., 2012.
3. D.C. Montgomery, *Introduction to Statistical Quality Control*, John Wieley and Sons, 2005.
4. J.M. Juran, F.M. Gryna, *Quality Planning and Analysis,* Tata McGraw Hill Publications, 1995.
5. L. Bertrand Hansen, *Quality Control- Theory and Applications*, Prentice Hall India, 1987.

ME2082: ENGINEERING ECONOMICS [3 0 0 3]

Introduction to Economics: Micro & Macro, Value, Utility, Consumer and producer goods, Factors of production. Demand and its types, Law of demand & supply, Elasticities of demand, Equilibrium of demand & supply, Law of variable proportions. Interest factors for discrete compounding. Comparison of alternatives based on: Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Capital recovery with return, Rate of return method, Incremental approach. Evaluation of replacement alternatives involving sunk costs, Replacement analysis for unequal lives. Nature of public activities and their evaluation based on benefit: Cost analysis, Identifying benefits, Dis-benefits and costs. Break Even Analysis for single product, Depreciation and depletion meaning and its methods.

References:

1. P.L. Mehta, *Engineering Economics*, Sultan Chand & sons, 2013.
2. E.L. Grant, W.G. Ireson and R.S. Leavenworth, *Principles of Engineering Economy*, John Wiley, 1990.
3. L. Blank and A. Tarquin, *Engineering Economy*, (7e), McGraw Hill Education, 2011.
4. J.L. Riggs, D.D. Bedworth and S.U. Randhawa, *Engineering Economics*, (4e), McGraw Hill Education, 1996.

ME2083: QUALITY MANAGEMENT [3 0 0 3]

Evolution of Quality Control, concept change, Quality concept in design, Review of design, inspection and control of product, Costs of quality, 7QC tools, Statistical Quality Control (SQC), Control charts (X-R, P, C) for Variables & attributes, Process capability, Quality assurance systems, Quality in sales and services, Acceptance sampling, OC curve, Concept of AOQL, Sampling plan: Single, Double & sequential, Introduction to TQM: Quality gurus & ISO - 9000.

References:

1. D.C. Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley & Sons Inc., 2008.
2. M. Mahajan, *Statistical Quality Control*, Dhanpat Rai, 2016.
3. E.L. Leavenworth, S. Richard and E.L. Grant, *Statistical Quality Control*, (7e), McGraw hill Education, 1972.
4. B.L. Hansen, P.M. Ghare, *Quality Control and Application*, (1e), Prentice Hall, 1987.

ME3080: WELDING TECHNOLOGY [3 0 0 3]

Introduction: Review of Conventional Welding Processes, Welding of Dissimilar Metals. Gas Welding Processes: Gas Welding Processes and Equipment's. Arc Welding Processes and Equipment's, Arc Mechanism, Heat and Temperature effect in Arc Welding, Fusion, Cooling and Solidification of weld metal, welding electrode specification. Resistance Welding Processes: Fundamentals of Heat and Pressure in Resistance Welding. Solid State Welding: Principle of operation and applications. Laser Beam and Electron Beam Welding processes and their applications. Special Welding Techniques: Underwater welding; welding of Pipelines and Piping, Welding Defects, Testing and Inspection.

References:

1. H.B. Cary, *Modern Welding Technology*, (3e), Prentice Hall Publishers, 1993.
2. P.T. Houldcroft, *Welding Process Technology*, Industrial Press Inc., 1998.
3. R.S. Parmer, *Welding Engineering & Technology*, Khanna Publishers, 1999.
4. V.M. Radhakrishnan, *Welding Technology and Design*, (2e), New Age International Pvt Ltd, 2005.

ME3081: MODERN MANUFACTURING [3 0 0 3]

Introduction: Trends in modern manufacturing; characteristics and classification of modern manufacturing methods, considerations in the process selection. Mechanical Processes: Introduction, principle, process description, material removal mechanism, parametric analysis of USM, AJM, WJM and AWJM processes. ECM, ECG, Electrochemical honing and Chemical Machining processes. EDM, Wire EDM, LBM, EBM, PAM. Hybrid

Machining Processes: Concept, classification, and applications of various hybrid machining methods based on USM, EDM, ECM, etc. Micromachining Processes.

References:

1. P.C. Pandey and H.S. Shan, *Modern Machining Processes*, Tata Mcgraw Hill, 2003.
2. S. Kalpakjian, *Manufacturing Engineering and Technology*, (4e), Addison Wesley Longman, 2002.
3. A. Ghosh, A.K. Malik, *Manufacturing Science*, (2e), Affiliated East West Press Pvt. Ltd., 2010.
4. P.K. Mishra, *Nonconventional machining*, Narosa publishing house, 2011.
5. V.K. Jain, *Introduction to micro machining*, (1e), Narosa publishing house, New Delhi, 2010

ME3082: PRODUCTION MANAGEMENT [3 0 0 3]

Production management system, its need and requirement, Production planning control, Various methods of forecasting, Aggregate planning, Master production scheduling-Types of scheduling and need for re-scheduling, Cost planning and control, capacity planning, Manufacturing Resource Planning, Inventory management, Material requirement planning (MRP),Working and benefits of different types of inventory system ,Performance measures ,Lot sizing methods, Just In Time, Pull and push system ,Kanban Shop floor Control, Enterprise Resource Planning (ERP)**.**

References:

1. S.N. Chary, *Production & Operations Management*, (5e), McGraw Hill Publication, 2017.
2. S.S. Buffa, *Modern Production Management*, (8e), John Wiley Publication, 2019.
3. E. E. Adam, R. J. Ebert, *Production and Operation Management: Concepts, Models, and Behaviour*, (5e), Prentice Hall Publishers, 1992.
4. P. Kumar, *Industrial Engineering and Management*, (1e), Pearson Publication, 2015.

ME3083: OPTIMIZATION IN ENGINEERING DESIGN [3 0 0 3]

Introduction to optimization, adequate and optimum design, formulation of objective function, design constraints. Classical optimization techniques: Single variable optimization, multivariable optimization with no constraints, exhaustive search, Fibonacci method, golden selection, Random, pattern and gradient search methods, Interpolation methods: quadratic and cubic, direct root method. Multivariable unconstrained and constrained optimization: Direct search methods, descent methods, conjugate gradient method. Indirect methods, Transformation techniques, penalty function method. Non-traditional optimization techniques: Genetic Algorithms, Particle Swarm Optimization Algorithm, etc. Optimum design of machine elements: Desirable and undesirable effects, functional requirement, material and geometrical parameters, Design of simple axial, transverse loaded members for minimum cost and minimum weight.

References:

1. S.S. Rao, *Engineering Optimization: Theory and Practice*, John Wiley & Sons, 1996.
2. K. Deb, *Optimization for Engineering Design*, Prentice Hall of India,2nd Edition, 2012.
3. J.S. Arora, *Introduction to Optimum Design*, Elsevier, Academic Press., 4th Edition, 2016
4. R.L. Fox, *Optimization Methods for Engineering Design*, Addison-Wesley Publication Co., 1971.

ME3084: RELIABILITY, AVAILABILITY AND MAINTENANCE ENGINEERING [3 0 0 3]

Introduction: Types of System; Series system; Parallel system; Series-Parallel System; Redundancy in Systems. Difference between System and Component: System and Component Reliability. Definition and concept; MTBF, MTTF, MTTR concept, Bathtub curve concept. Reliability in terms of Hazard rate, CDF,PDF; Repairable and Non-Repairable Systems; Reliability data and censoring Approaches; Probability Distributions and Distribution Models: Discrete and Continuous Distribution; Normal Distribution; Exponential Distribution; Weibull Distribution; Point, mission and steady state availability, Availability assessment. Maintainability and its assessment, design for reliability and maintainability.

References:

1. C.E. Ebeling, *An Introduction to Reliability and Maintainability Engineering*, McGraw Hill Publication, 2005.
2. S.S. Rao, *Reliability Engineering*, Pearson Publication, 2016.
3. K.C. Kapoor and L.R. Lamberson, *Reliability in Engineering Design*, John Wiley Publication, 2015
4. E. Balagurusamy, *Reliability Engineering*, McGraw Hill Publication, 2018.

ME3085: ENERGY ENGINEERING [3 0 0 3]

Introduction, global and Indian energy scenario. Current energy sources, Energy scarcity and reasons, Energy conversion techniques: conventional and direct energy conversion techniques, applications and limitations. Energy efficiency measures and energy conservation technologies. Non-conventional sources of energy, Renewable energy: solar energy technologies, solar radiation and collectors, solar photovoltaic systems, wind energy, bio-energy and hybrid-systems. Energy storage systems, need and importance. Role of energy engineering in cleaner and greener environment.

References:

1. Albert Thumann, *Handbook of Energy Engineering*, (5e), The Fairmont Press Inc., 2001.
2. Nick Jenkins and Janaka Ekanyake, *Renewable Energy Engineering*, (1e), Cambridge University Press, 2017.

ME3086: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]

Introduction to Safety Engineering, Industrial Accidents, Theories of Accident Causation, Introduction to Health and Toxic Substances, Environmental Control and Noise, Ventilation and its Design Principle, Personal Protection and First Aid, Fire Protection, Machine Guarding, Safeguarding the point of operation, Power presses, Grinding machines, Saws, Belts and Pulleys, Safety consideration regarding material handling and storage. Safety Requirement for Material Handling and Storage, Electrical Hazards, Employee Participation in Promoting Safety, Safety Training, Safety Committees, Teamwork Approach to Promoting Safety.

References:

1. C.R. Asfahl and D.W. Rieske, *Industrial Safety and Health Management*, (6e), Pearson Education, 2011.
2. F.R. Spellman, N.E. Whiting, *The Handbook of Safety Engineering: Principles and Applications, Government Institutes*, 2009.
3. A. Gupta, *Industrial Safety and Environment*, (1e), Laxmi Publications Pvt. Ltd., 2006.
4. D.L. Goetsch, *Occupational Safety and Health for Technologists, Engineers and Managers*, (8e), Pearson Education Limited, 2014.

ME3087: PRINCIPLES OF INDUSTRIAL ENGINEERING [3 0 0 3]

Introduction to Industrial engineering: Method study, THERBLIGS, Work measurement methods, Productivity, Ergonomics, Job evaluation: Methods & Incentives, Break Even Analysis, Facility location factors and evaluation of alternate locations, Types of plant layout and their evaluation, Computer aided layout design techniques, Assembly line balancing, Materials handling systems.

References:

1. S.N. Chary, *Production and Operations Management*, (6e), McGraw Hill Education, 2015.
2. S.S. Buffa, *Modern Production Management*, (8e), John Wiley, 2007.
3. J.G. Monks, *Operation Management*, (2e), McGraw Hill Education, 1996.
4. J.S. Martinich*, Production & Operations Management*, John Wiley, 2008.
5. A.B. Badiru, *Industrial & Systems Engineering,* (2e), CRC Press, 2013.

Department of Mechtaronics Engineering

Mechatronics engineering is an emerging field of engineering which involves the combination of different disciplines viz. Mechanical, Electronics & Electrical, Instrumentation and Computer Science Engineering. The course curriculum has been designed aptly to cater the ever expanding demands of research and industry by consolidating the views of all stake holders. The main objective of the department is to impart a quality education and make the students industry ready.

The Department was established in the year 2012, offering B. Tech degree with an intake of 90. Faculty members in the department are well qualified and have rich teaching and research experience. The various specialization of faculties include interdisciplinary areas like Robotics & Automation, Industrial Engineering, Instrumentation & control and Micro-Electro-Mechanical Systems etc. The department has a team of 14 dedicated faculty members who are capable of providing state-of-art exposure to students with quality approach to research and development. The Department has well equipped laboratory facilities having Sensoric and Hydraulic Labs with industrial level equipment's set up in collaboration with Bosch Rexroth India Ltd. Additionally, other laboratories includes Programmable Logic Controllers, Microcontroller, Mechatronics System Design, Pneumatics and Electronics Measurement & Instrumentation Lab. In addition, these laboratories are equipped with Quanser, Janatics, National Instruments and Siemens make equipments. To enhance the skills and foster the individual growth, the department has a robotics club in which the students develop robots and it also provides guidance to interested students apart from taking up specific projects.

B.Tech in Mechatronics Engineering
(Course Structure & Syllabus III Semester Onwards)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Course Code	Subject Name	L	T	P	C	Course Code	Subject Name	L	T	P	C
II	BB0025	Value, Ethics and Governance	2	0	0	2	EO 2001	Economics	3	0	0	3
	MA2102	Engineering Mathematics-III	2	1	0	3	MA 2204	Engineering Mathematics-IV	2	1	0	3
	MC2101	Strength of Materials	3	1	0	4	MC2201	Design of Machine Elements	3	1	0	4
	MC2102	Linear Integrated Circuits	3	1	0	4	MC2202	Digital System Design	3	0	0	3
	MC2103	Theory of Machines	3	1	0	4	MC2203	Fluid Mechanics	3	1	0	4
	MC2104	Sensor and Instrumentation	3	0	0	3	XX 20XX	Open Elective-I	3	0	0	3
	MC2130	Simulation and Modelling Lab	0	0	2	1	MC2230	Programmable Logic Controller Lab	0	0	3	1
	MC2131	Sensor& Instrumentation Lab	0	0	2	1	MC2231	Integrated Electronics Lab	0	0	2	1
	MC2170	Seminar	0	0	2	1	MC2270	Project Based Learning-I	0	0	2	1
			16	4	6	23			17	3	7	23
	Total Contact Hours (L + T + P)		26				Total Contact Hours (L + T + P)+OE		27			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	BB 0026	Organization and Management	3	0	0	3	MC3201	Robotics	3	1	0	4
	MC3101	Signal and Systems	3	0	0	3	MC3202	Computer Integrated Manufacturing	3	1	0	4
	MC3102	Microcontroller Based System Design	3	1	0	4	MC3203	Power Electronics and Electrical Drives	3	1	0	4
	MC3103	Pneumatic and Hydraulic Systems	3	1	0	4	MC32XX	Program Elective-I	3	0	0	3
	MC3104	Linear Control Theory	3	1	0	4	MC32XX	Program Elective-II	3	0	0	3
	XX 30XX	Open Elective-II	3	0	0	3	XX 30XX	Open Elective-III	3	0	0	3
	MC3130	Microcontroller Lab	0	0	2	1	MC3230	Industrial Automation Lab	0	0	2	1
	MC3131	CAD and Kinematics Lab	0	0	2	1	MC3231	Robotics Lab	0	0	2	1
	MC3132	Pneumatics and Hydraulics Lab	0	0	2	1	MC3232	Drives, Control and Simulation Lab	0	0	2	1
	MC3170	Project Based Learning-II	0	0	2	1	MC3270	Project Based Learning-III	0	0	2	1
			18	3	8	25			18	3	8	25
	Total Contact Hours (L + T + P)+OE		29				Total Contact Hours (L + T + P)+OE		29			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	MC41XX	Program Elective-III	3	0	0	3	MC4270	Major Project	0	0	0	12
	MC41XX	Program Elective-IV	3	0	0	3						
	MC41XX	Program Elective-V	3	0	0	3						
	MC41XX	Program Elective-VI	3	0	0	3						
	MC41XX	Program Elective-VII	3	0	0	3						
	MC4170	Minor Project	0	0	2	1						
	MC4171	Industrial Training	0	0	2	1						
			15	0	4	17			0	0	0	12
	Total Contact Hours (L + T + P)		19				Total Credits=169(including first year)		12			

THIRD SEMESTER

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case StudiesX.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects. CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

6. Professional Module of ICSI.
7. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
8. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
9. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
10. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications

MA2102: ENGINEERING MATHEMATICS – III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation-Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

5. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
6. S.S. Sastry, *Introductory methods for Numerical Analysis*, (5e), PHI Learning Private Limited, 2012.
7. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.

MC2101: STRENGTH OF MATERIALS [3 1 0 4]

Stress, Strain and Deformation of Solids: Concept of stress and strain. Deformation of simple and compound bars under axial load, Hooke's law, Stress-Strain diagrams for materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Saint Venant's principle, Thermal stress, Elastic constants, Strain energy, Biaxial state of stresses, Deformation in thick & thin cylindrical and spherical shells, Stresses on inclined plane, Principal planes and stresses, Shear force and Bending Moment in Cantilever, Simply supported and Overhanging beams, Theory of simple bending, Effect of shape of beam section on stress induced with different types of loading , Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections, Torsion: Analysis of torsion of circular bars, Shear stress distribution for Solid and hollow circular section, Stepped shaft, Twist and torsion stiffness, Fixed and simply supported shafts, Introduction, short and long columns. Euler's theory; Assumptions, Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.

References:

1. E. P. Popov, *Engineering Mechanics of Solids,* (2e), Prentice-Hall of India, New Delhi. 2015
2. F. P. Beer and R. Johnston, *Mechanics of Materials*, (3e), McGraw-Hill Book Co, 2002.
3. S. M. A. Kazimi, *Solid Mechanics*, Tata McGraw-Hill, New Delhi 2001.
4. G. H. Ryder, *Strength of Materials*, 3rd Edition, Macmillan India Ltd., 2002.

MC2102: LINEAR INTEGRATED CIRCUITS [3 1 0 4]

Operational Amplifier: Introduction: Introduction to analog system design, Review of Op-Amp basics, internal block diagram, characteristics of ideal operational amplifier, Linear applications of operational amplifier: Open loop and closed loop operation of operational amplifier, Inverting amplifier, non-inverting amplifier, various configuration of Op-Amp, Active filters: Design and analysis of first and higher order low pass, high pass, band pass and band elimination and all pass active filters, Non-linear applications of operational amplifier: Precision half wave and full wave rectifiers, peak detector, sample and hold circuit, log and antilog amplifiers, analog multipliers and dividers, comparators, window detector, Schmitt trigger, square wave, triangular wave generators and pulse generator, Timer: Introduction, pin details of 555 I.C., functional diagram of 555 IC, Multi-vibrators, linear ramp generator and FSK generator, Data converters: Principles of digital to analog converter (DAC) and analog to digital converters (ADC), specifications of ADC and DAC, Regulated power supplies using IC's: Analysis and design of linear series voltage regulators using 78XX and 79XX series, LM317. Current Feedback Op-Amp.

References:

1. Franco Sergio, *Design with Op-amps and Analog Integrated Circuits*, McGraw Hill, 4th Edition, 2015.
2. Choudhury Roy D and Shail B. Jain, *Linear Integrated Circuits*, Wiley Eastern, 4th Edition, 2011.
3. Ramakant A. Gaikwad, *Op-Amps and Linear Integrated Circuits*, Prentice Hall of India, 4th Edition, 2009.
4. Stanley William D., *Operational Amplifiers with Linear Integrated Circuits*, Pearson, 4th Edition, 2004.

MC2103: THEORY OF MACHINES [3 1 0 4]

Basic Concepts: Mechanism and machine, kinematic chain, constrained and unconstrained motions, four bar mechanism, Kutzbach criterion, Grashoph's law, single and double slider crank mechanisms with inversions, transmission angle, toggle positon and mechanism, Mechanical advantage, snap action mechanism, indexing mechanism. Position analysis: using graphical method, algebraic method, complex polar algebra method, vector (chace) method, Kennedy's theorem, coupler curve generation. Velocity and acceleration of slider–crank mechanism and crank & slotted lever mechanism: using graphical method, analytical method, complex polar method and vector (chace) method and I-Centre method. Synthesis of linkages: introduction to function generation and path generation, graphical method– two and three point synthesis, chebychev spacing, overlay method, cognate linkages, freudenstein's equation, introduction to analytical synthesis. Design of pantograph, straight line mechanisms and parallel linkages. Gears and gear train: introduction, gear terminology, simple gear train, compound gear train, reverted gear train, planetary or epicyclic gear train, differentials. Cams: introduction, cam terminology, motion of follower. Gyroscope: introduction, precessional angular motion, gyroscopic couple, effect of gyroscopic couple on aeroplane, naval ship, stability of a four wheel and two wheel drive moving in a curved path.

References:

1. S. S. Rattan, *Theory of Machines* (4e), McGraw Hill Educations, 2017
2. R.L Norton, *Kinematics & Dynamics of Machinery*, (5e), McGraw Hill Educations, 2017
3. Kevin Russell, *Kinematics and dynamics of mechanical systems Implementation in MATLAB and SimMechanics*, (2e), 2015
4. John J. Uicker, *Theory of Machines and Mechanisms*, (4e), Oxford, 2014

MC2104: SENSOR AND INSTRUMENTATION [3 0 0 3]

Calibration, static and dynamic characteristics of an instrument, error analysis, electromechanical indicating Instruments. Analog and digital voltmeters, ammeters, multimeters, DC bridges, AC bridges, fault detection, potentiometers, physical quantities and their measurements- Sensor classification and characteristics, strain, force, acceleration, proximity and range, temperature, pressure, flow, level, light, Linear displacement, acoustic wave, vibration, Velocity. Display device- digital CRO, elements of data acquisition system, concept of signal conditioning.

References:

1. Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, (2e), CRC Press, 2015.
2. A.K. Sawhney, *A course in Electrical and Electronic Measurements and Instrumentation*, (19e), Dhanpat Rai & Co. Publishers, 2012.
3. Bela G. Liptak, *Process Measurement and Analysis*, (4e), CRC press, 2003.
4. John G. Webster, *The Measurement, Instrumentation, and Sensors: Handbook*, Springer Science & Business Media, 1999.

MC2130: SIMULATION AND MODELLING LAB [0 0 2 1]

Basics of MATLAB, Loops, conditions and cases, if-then-else statements, logical operations, Call functions, arrays/vectors/matrices, plotting. Basics of MATLAB Simulink, Kinematic linkages in Simulink, Interfacing of Arduino/Raspberry Pi with MATLAB. Position analysis, Velocity and acceleration analysis of kinematic linkages.

References:

4. Amos Gilat, *MATLAB: An Introduction with Applications*,(5e), Wiley Publication, 2014.
5. Stormy Attaway, *MATLAB: A Practical Introduction to Programming and Problem Solving*, (4e), Butterworth-Heinemann Publication, 2016.
6. Harold Klee, *Simulation of Dynamic Systems with MATLAB and Simulink*, CRC Press, 2018.
7. Kevin Russell, Qiong Shen, Rajpal S. Sodhi, *Kinematics and Dynamics of Mechanical Systems, Second Edition: Implementation in MATLAB® and SimMechanics®*, (2e), CRC Press, 2018.
8. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer Science & Business Media, 2010.

MC2131: SENSOR AND INSTRUMENTATION LAB [0 0 2 1]

Behavior of capacitive sensor, inductive sensor, magnetic sensor, light sensor and ultrasonic sensor. Switching frequency and switching distance and hysteresis of NBN, CJ, MB, OJ. Calculation of maximum admissible velocity of an object using ultrasonic sensor. Accelerometer sensor. Characteristics of Temperature sensor, Strain Measurement, Displacement measurement using LVDT. Sensor data analysis using Raspberry Pi /Arduino.

References:

1. A.K. Sawhney, *A course in Electrical and Electronic Measurements and Instrumentation*, (19e), Dhanpat Rai & Co. Publishers, 2012.
2. Bela G. Liptak, *Process Measurement and Analysis*, (4e), CRC press, 2003.
3. John G. Webster, *The Measurement, Instrumentation, and Sensors: Handbook, Springer Science & Business Media, 1999.*
4. Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, (2e), CRC Press, 2015.

MC2170: SEMINAR [0 0 2 1]

Each student has to present a seminar on any technical topic. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/ question & answers; The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance; Each student has to submit to the department a seminar report at least three days before the day of seminar; Each student has to make the power point presentation (ppt).

FOURTH SEMESTER

EO 2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behavior, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA 2204: ENGINEERING MATHEMATICS IV [2 1 0 3]

Probability: Introduction, finite sample spaces, conditional probability and independence, Baye's theorem, one dimensional random variable, mean, variance. Two and higher dimensional random variables: mean, variance, correlation coefficient. Distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, simple problems. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. Finite difference expressions for first and second order derivatives (ordinary and partial): Solution of boundary value problems, Numerical solutions of Laplace and Poisson equations by standard five point formula and heat and wave equations by explicit methods. Difference equations: Difference equations representing physical systems, difference operator, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms.

References:

1. Dean G. Duffy, *Advanced Engineering Mathematics with MATLAB*, CRC Press, 2016.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
3. Alan Jeffrey, *Advanced Engineering Mathematics*, Academic Press, 2001.
4. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.

MC2201: DESIGN OF MACHINE ELEMENTS [3 1 0 4]

Basic Concepts: Fundamentals of Mechanical Design: The Design Process, Economics of Design, Reliability, Safety and Product Liability, Codes and Standards, Types of Materials, Stress-Strain Response, Types Of Loads and Stresses, Failure Modes, Factor of Safety, Strength Design. Static And Variable Stress Analysis: Static Strength, Failure Theories, Stress Concentration, Fatigue Strength, Stress-Life (S-N) Diagram, High Cycle Fatigue, Endurance Limit Modifying Factors, Effect of Mean Stress, Fluctuating Stresses, and Stresses due to Combined Loading. Design For Static And Fatigue Load, Coil Springs: Helical Coil Spring: Compression Springs of Round/Square/Rectangular Wires, Spring Materials, Stress And Deflection of Spring Subjected to Steady, Fluctuating and Impact Loads, Spring Surge and Buckling, Concentric Springs. Gears: Spur and Helical Gears: Merits, Terminology, Tooth Profile, Pressure Angle, Lewis Equation for Beam Strength, Form Factor, Velocity Factor, Design for Static Loads, Design for Dynamic and Wear Loads. Sensing and measurement of mechanical motion, computer programs to calculate stresses and deflection in simple machine members.

References:

1. V B Bhandari, *Design of Machine Elements*, (4e), Tata McGraw Hill, 2017
2. Ferdinand Beer, E. Russell Johnston Jr., *Mechanics of Materials*, (7e), McGraw Hill, 2014
3. Jospeh E. Shigley, *Mechanical Engineering Design*, (5e), McGraw Hill Inc, New York. 2004
4. Stephen Timoshenko, *Elements of Strength of Materials* (5e), Tata McGraw Hill, 2003.
5. Egor P. Popov, *Engineering Mechanics of Solids* (2e), Prentice Hall India, 2001.

MC2202: DIGITAL SYSTEM DESIGN [3 0 0 3]

Concept of K-Maps reduction, Design of combinational circuits: Adder, Subtractor, Encoder, Decoder, Multiplexer, Demultiplexer. Design sequential circuits by using memory elements like latches , flip-flops, Counters, Registers, Synchronous Counters , Asynchronous counters, Logic families, Analysis and Design of Finite State Machines, Sequence Generator and Sequence Detector-Lock out condition, Design examples, Introduction to ASM charts. Basics of FPGA Architecture.

References:

1. Morris Mano, *Digital Design*, Prentice Hall Publishers, (5e), 2013
2. A. Anand Kumar, *Switching Theory and Logic Design*, (2e), Prentice
3. David J Comer, *Digital Logic State Machine Design*, (3e), Oxford University Press, 2012.
4. Samir Palnitkar, Verilog *HDL: A Guide to Digital Design and Synthesis*, (2e), Prentice Hall PTR, 2003.

MC2203: FLUID MECHANICS [3 1 0 4]

Fundamentals: Definition and properties of fluids, intensity of pressure, variation of pressure in a static fluid, Absolute, Gauge, Atmospheric and Vacuum pressure Manometers, Fluid statics: Hydro static forces and center of

Pressure on vertical and inclined plane surfaces, Buoyancy, center of Buoyancy, Metacentre and Meta-centric height, Analytical method for determination of Meta-centric height, Stability of floating and sub-merged bodies, Kinematics and Dynamics of fluid flow : Types of fluid flow, continuity equation, one dimensional Euler's equation of motion, Bernoulli's energy equation, Fluid flow measurements: Pitot tube, orifice meter and venture meter, Fluid flow in pipes: Darcy weisbach equation. Losses in pipes - Minor and major losses, Dimensional analysis and Similitude: Methods of dimensional analysis, similitude.

References:

1. Frank M. White, *Fluid Mechanics*, McGraw Hill, 7th edition, 2011.
2. Yunus A Cengel and John M. Cimbala, *Tata McGraw-Hill Education*, 3rd edition, 2010
3. Victor Lyle Streeter, E. Benjamin Wylie, *Fluid mechanics*, McGraw Hill, 7th edition, 2007

MC2230: PROGRAMMABLE LOGIC CONTROLLER LAB [0 0 3 1]

Introduction of PLC, study basic components, networking and different programming technique of PLC. Study NO, NC and holding circuit programs, Implementation of Ladder program for timers, counters, math, logical and program control instructions. Study different applications using ladder logic. Analog PLC operations – Accessing Analog inputs, Process and control analog outputs, Conveyor control Systems, Stepper Motor Control, Traffic light Control, Lift Control, Bottling Plant, HMI, Mini project.

References:

1. F. D. Petruzella, *Programmable Logic Controllers*, 4th edition, McGraw- Hills Publications, 2010.
2. *Siemens PLC Handbook*, Siemens
3. John W. Webb and Ronald A. Reiss, *Programmable logic controllers-Principle and applications*, 5th edition, PHI, 2003.

MC2231: INTEGRATED ELECTRONICS LAB [0 0 2 1]

Analog circuit designs using 741 IC, linear applications of Op-amps: design of rectifiers, DACs and ADCs, filters, multivibrators & Schmitt trigger using 555 IC, regulators. Digital circuit designs- combinational circuit's, implementation of Boolean functions and arithmetic circuits, multiplexers, encoders, decoders, code converters, design of sequential circuits- ripple counters, shift registers and ring counters, synchronous counters, sequence detectors.

References:

1. Franco Sergio, *Design with Op amps & Analog Integrated Circuits*, McGraw Hill, 3rd Edition, 2001
2. M. Morris, and M. D. Ciletti, *Digital design- with an introduction to the Verilog HDL*, Pearson, 5th edition, 2013.

MC2270: PROJECT BASED LEARNING-I [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

FIFTH SEMESTER

BB0026: ORGANIZATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs,

Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

References:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, *Essentials of Management*,(1e) Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

MC3101: SIGNAL AND SYSTEMS [3 0 0 3]

Introduction: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties of systems. Time domain representations for linear time-invariant systems: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems, Differential and difference equation representations for LTI systems, Block diagram representations. Fourier representation for signals: The discrete-time Fourier series, continuous-time periodic signals: The Fourier series, Discrete-time non-periodic signals: The discrete-time Fourier transform, continuous-time non-periodic signals: The Fourier transform, properties of Fourier representations, Discrete-time periodic signals, Fast Fourier transform. S-domain transformation using Laplace transform. Filter design. Signal processing in MATLAB.

References:

1. Ramesh Babu, *Signals & Systems*, 4th edition, Scitech Publications (Ind, 2011)
2. S. Haykin & B. V. Veen*, Signals and Systems*, John Wiley &Sons, New Delhi, 2nd edition, 2002.
3. J.G. Proakis, D.G. Manolakis, D. Mimitris, *Introduction to Digital Signal Processing*, Prentice Hall, India, 4th Edition, 2006.

MC3102: MICROCONTROLLER BASED SYSTEM DESIGN [3 1 0 4]

Introduction to 8085, Comparison between 8085 and 8051, Introduction to 8051: Introduction to embedded controllers, Harvard vs. Von Neumann architecture, commercial microcontroller devices. Architecture of 8051: Registers, Register Banks, PSW, CPU, PC, DPTR, SFRs, RAM, ROM, Stack); Programming model of 8051, Pin diagram & details, I/O Ports & details. 8051 Assembly Language Programming: Assembler Directives, Addressing Modes of 8051, Instruction set, calculation of delay, delay programs. Timers, Counters, Serial Communication, Interrupts, Programming examples. 8051 Programming in Embedded C: Data types in embedded C, arithmetic & logic operators, control statements and loops in embedded C, functions & arrays, I/O port programming, programming timers & counters, Interrupts & Serial communication program. Hardware Interfacing: Programmable I/O (8255); Memory Interfacing, Stepper Motor, DAC, ADC, Seven Segment Display, LCD, Relays & Optoisolators. Design of Microcontroller based systems: Introduction to other Microcontroller families (PIC, AVR and ARM).

References:

1. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Pearson Education, 2010.
2. Myke Predko, *Programming and Customizing the 8051 Microcontroller*, Tata McGraw Hill, 2007.
3. Kenneth J. Ayala, 8051 *Microcontroller and Embedded Systems using Assembly and C*, Cengage Learning, 2010.
4. Ajay V. Deshmukh, *Micro controllers- Theory and Applications*, TMH, New Delhi, 2008.

MC3103: PNEUMATIC & HYDRAULIC SYSTEMS [3 1 0 4]

Introduction to Fluid Power: Hydraulics and Pneumatics, Fluid power and fluid transport system, advantages, disadvantages and applications. Components: functions and properties of Hydraulic fluid, Pascal's law application,

hydraulic power, siphon effect. Hydraulic components: losses in valves and fittings, hydraulic circuit analysis, pumping theory, classification of pumps, Volumetric displacement and flow rate for gear, vane and axial piston pump, performance and selection. Cylinder: construction and mountings, force, velocity and power, cylinder load due to moving weight and cylinder loadings. Motors: types, torque, power and flow rate, performance. Valves: DC valves, check, pilot, 3-way, 4-way, manually, mechanically and solenoid actuated valves, shuttle valve, Twin pressure valves, Shuttle valves ,Servo valves, Pressure control valves Pressure relief valve, pressure reducing valve, pressure compensation valve, symbols of valves. Hydraulic Circuits: with different components and objectives, hose size calculations. Pneumatics: Compressor types, capacity ratings, sizing of receiver, FRL, sizing of valves, actuators-cylinders and motors. Circuits: design considerations, air losses in pipe lines. Pneumatic circuit analysis. .Circuit design: Motion diagram, Cascading method, Karnaugh –Veitch method, electrical controls in pneumatic circuits. Electro pneumatics and design of electro pneumatic circuits, timers, counters.

References:

1. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
2. P. A. Andrew, *Hydraulics and Pneumatics*, Elsevier Science &Technology Books, (3e) 2011.
3. D. Scholz., *Proportional Hydraulics*, Festo Didactic GMBH & Co, Germany, 2002.
4. S. R Majumdar, *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

MC3104: LINEAR CONTROL THEORY [3 1 0 4]

Introduction: Feedback control systems, Physical systems, signal flow graph, Time domain specification. Frequency Domain Analysis, Routh Hurwitz criteria for absolute / relative stability. Root locus plots, Bode plots- gain margin and phase margin, Polar plots, Nyquist stability criterion, gain margin and phase margin, System Compensation: Using elementary lag, lead and lead- lag compensating networks. Phase lead design using Bode diagram and root locus. Phase lag design using Bode diagram and root locus. Phase lag- lead design using Bode diagram and root locus. Pole Placement using Root locus. State Space Analysis.

References:

1. Norman S. Nise, *Control Systems Engineering*, (6e), Wiley India.
2. R.C Dorf, R. H. Bishop, *Modern Control Systems*, (8e), Wesley Longman Inc.
3. B.C. Kuo, F. Golnaraghi, *Automatic Control Systems*, (8e), Wiley India.
4. K. Ogata, *Modern Control Engineering*, (5e), PHI.
5. M. Gopal, *Control System: Principles and Practices*, (4e), TMH.

MC3130: MICROCONTROLLER LAB [0 0 2 1]

Microcontroller: Introduction to 8051, arithmetic instructions, array handling and code conversions, bit manipulations and logic instructions, timer/counter programming, serial communication and interrupts, interfacing ADC with 8051, interfacing stepper motor with 8051, interfacing DAC with 8051, interfacing logic controller with 8051, interfacing seven segment display with 8051, interfacing LCD with 8051, implementing a traffic light controller using 8051.

References:

1. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Pearson Education, 2010.
2. Myke Predko, *Programming and Customizing the 8051 Microcontroller*, Tata McGraw Hill, 2007.
3. Kenneth J. Ayala, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Cengage Learning, 2010.
4. Ajay V. Deshmukh, *Microcontrollers- Theory and Applications*, Tata McGraw Hill, 2008.
5. Krishna Kant, *Microprocessors and Microcontrollers*, PHI, 2007

MC3131: CAD AND KINEMATICS LAB [0 0 2 1]

2D and 3D design modelling using Auto CAD and CREO. Assembly and animation of mechanical linkages. Design of machine elements like shaft, cotter joint, springs, linkages, couplings, etc.

References:

1. I. Zeid, *CAD/CAM Theory and Practice* (2e), McGraw Hill Education, 2012

MC3132: PNEUMATICS & HYDRAULICS LAB [0 0 2 1]

Operations of various valves like directional control valves, flow control, valves, pressure control valves and switches like pressure switches, proximity switches. Operations of timers and counters. Rigging of manual pneumatic and electro-pneumatic circuits using above valves and switches. Working principles of hydraulic pumps, hydraulic motors, throttle valves, direction control valves. Manual and electro hydraulic circuits using above components. Manual and electro hydraulic circuits using above components.

References:

1. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
2. S. R Majumdar, *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

MC3170: PROJECT BASED LEARNING-II [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SIXTH SEMESTER

MC3201: ROBOTICS [3 1 0 4]

Introduction of robots and its types, degrees of Freedom of robot, Robot Configuration, Specification of a robot; Manipulator Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Differential motions and velocity: Differential motions of joints and robot, Jacobians, Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Robot statics, Trajectory planning: Joint space trajectory planning, Cartesian space trajectory planning. Kinematics of wheeled mobile robots.

Reference:

1. Y Kozyhev, *Industrial Robots Handbook, MIR Publications*, 2nd edition, 1999.
2. S.B. Niku, *Introduction to Robotics Analysis, Control Applications*, Wiley Publications,2nd edition,2011.
3. Tzafestas, Spyros G. *Introduction to mobile robot control*. Elsevier, 2013.
4. Spong, Vidyasagar, *Robot Dynamics and Control,* Wiley Publications, 2nd edition2009
5. K. Yoram, *Robotics*, McGraw Hill Publications, 1992.

MC3202: COMPUTER INTEGRATED MANUFACTURING [3 1 0 4]

Numerical Control Production Systems: Components of NC Machine, CNC Machine, Classification, Advantages and disadvantages, Control loop of point to point systems, Control loop of contouring systems. CNC Tooling, CNC programming: Co-ordinate systems, CNC programming for Turning Center and Machining center by Manual method (word address format only), Manual data input, Distributed Numerical Control, Group Technology , FMS and CIM: Part families – Part classification and coding, production flow analysis, machine cell design, benefits of GT, Computer Integrated Manufacturing System, Types of Manufacturing System, Material Handling System, Analysis of storage systems, Single station manufacturing cells, Flexible Manufacturing System, FMS work station, Types of FMS Layouts, fundamentals of CIM and Benefits of CIM, Single Station Manned /Automated Workstations: Parts Storage Subsystem and Automatic Parts Transfer, Analysis of Single Station Cells. Analysis Of Automated Flow Line & Line Balancing: General terminology and analysis, Analysis of Transfer Line, Partial automation-with numerical problems. Computerized Manufacturing Planning Systems: Computer aided Process planning, Computer integrated planning systems.

References:

1. K. Yoram, Ben and U. Joseph, *Numerical Control of Machine Tools*, Khanna Publishers, New Delhi, 2005.
2. Mikell P. Groover, and Emory W. Zimmers, *Computer aided design and manufacturing*, Prentice Hall of India, New Delhi, 2003.

3. P. Radhakrishnan, *Computer Numerical Control Machines*, New Central Book Agency Pvt. Ltd., Kolkata 2004 .
4. P.N Rao, *CAD/CAM*, Tata McGraw Hill, New Delhi, 2005.
5. Smid Peter, *CNC programming Hand book*, Industrial Press Inc., New York, 2000.

MC3203: POWER ELECTRONICS AND ELECTRICAL DRIVES [3 1 0 4]

Semiconductor devices: Power diode, SCR, GTO, BJT, MOSFET, IGBT. Power converters: ac to ac, ac to dc, dc to ac, dc to dc. DC Motors: construction, speed-torque characteristics, starting methods, speed control. AC Motors: Induction Motors, construction, starting methods, speed control. Servo motors, BLDC motors, Stepper motors. Electric Drives: Components of electric drives, factors affecting choice of drives, dynamics of electrical drives, fundamental torque equation, speed-torque conventions, multi-quadrant operation of electric drives, load torque components, equivalent moment of inertia, steady state stability, load equalization, motor power rating, motor duty cycles, Electric braking.

References:

1. G. K. Dubbey, Fundamentals of Electric Drives, (2e), Narosa Publishers, 2010
2. J. Nagrath and D. P. Kothari, Electric machines, (3e), Tata McGraw Hill, 2011
3. P.S. Bimbra , Power electronics, (3e), Khanna Publishers, 2010
4. R. Krishnan, Electric Motor Drives Modeling, Analysis, and Control, (2e), Prentice Hall, 2012
5. M.H. Rashid, Power Electronics: Circuits, Devices & Applications, (4e), Pearson, 2014

MC3230: INDUSTRIAL AUTOMATION LAB [0 0 2 1]

Single cycle automation of multiple cylinders using cascading method; Intermediated positioning of a double acting cylinder ; Use of pneumatic counter; Use of pressure sequence valve; Use of back pressure valve; Use of pneumatic PLC for automation for single and multiple cycle; Application of AND/ OR Logic; Electro-pneumatics AND/ OR logic; single cycle automation using relay; ON and OFF delay timer application for solenoid actuation; Use of double solenoid valve with capacitive sensors(Use plastic or metal cam for sensing); Use of double solenoid valve and electrical limit switch. Use of PLC for multi-cycle and sequential operation of actuators. Manual & electro Hydraulics.

References:

1. Bosch Rexroth AG, *Project Manual Industrial Hydraulics*, RE 00845/04.07.
2. Rexroth AG, *Trainer's Manual Electro Hydraulics*, R900071655.
3. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
4. S. R Majumdar., *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000

MC3231: ROBOTICS LAB [0 0 2 1]

Forward and inverse kinematics of a Robot, velocity analysis, Mobile robot, Dynamics of Robot Manipulators, Control of Robot Manipulators: PID control, Adaptive Control, Robot Path-Planning.

Reference:

1. Y Kozyhev, *Industrial Robots Handbook, MIR Publications*, 2nd edition, 1999.
2. S.B. Niku, *Introduction to Robotics Analysis, Control Applications*, Wiley Publications,2nd edition,2011.
3. Tzafestas, Spyros G. *Introduction to mobile robot control*. Elsevier, 2013.
4. Spong, Vidyasagar, *Robot Dynamics and Control,* Wiley Publications, 2nd edition2009
5. K. Yoram, *Robotics*, McGraw Hill Publications, 1992.
6. Craig, John J., *Introduction to Robotics: Mechanics and Control*, 2nd Edition, Addison Wesley, 1989

MC3232: DRIVES, CONTROL AND SIMULATION LAB [0 0 2 1]

Characteristics of SCR, IGBT MOSFET. Power converters, Control of DC Motors, induction Motors, BLDC Motor, Stepper Motor, Servo Motor.

References:

1. G. K. Dubbey, *Fundamentals of Electric Drives*, (2e), Narosa Publishers, 2010
2. I. J. Nagrath and D. P. Kothari , *Electric machines*, (3e), Tata McGraw Hill, 2011
3. P.S. Bimbra , *Power electronics*, (3e), Khanna Publishers, 2010
4. R. Krishnan*, Electric Motor Drives Modeling, Analysis, and Control*, (2e), Prentice Hall, 2012
5. M.H. Rashid, *Power Electronics: Circuits, Devices & Applications*, (4e), Pearson, 2014

MC3270: PROJECT BASED LEARNING-III [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SEVENTH SEMESTER

MC4170: MINOR PROJECT [0 0 2 1]

The project work may be carried out in institute laboratory. The duration of the project work shall be 16 weeks. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, as part of project evaluation.

MC4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a period of 4-6 weeks. This may be taken in a phased manner during the vacation starting from the end of six semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

EIGHT SEMESTER

MC4270: MAJOR PROJECT [0 0 0 12]

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry/ research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be on the basis of the total marks obtained by him/ her out of 400 marks. There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken. The final evaluation and viva voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

PROGRAM ELECTIVES-II, III, IV, V, VI, VII

MC4140: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

Temperature measurement using RTD, Thermistors and thermocouple. Solid-state temperature sensors, radiation methods, Pressure Measurement - Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement, Flow Measurement, head type flow meters, variable area flow meters, anemometers, velocity based flow meters, Measurement of mass flow rate - Radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine, target flow meters, V-cone flow meters, Multiphase flow measurement, Measurement of Speed, velocity and Acceleration, Level Measurement.

References:

1. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
2. Gioia Falcone, Geoffrey Hewitt, C Alimonti, Multiphase Flow Metering- Principles and Applications, Elsevier Publication, 2009.
3. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
4. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, (7e), Dhanpat Rai and Co, 2002

MC4141: MICRO ELECTRO MECHANICAL SYSTEMS [3 0 0 3]

Introduction to MEMS and microsystems - products, evolution of microfabrication, microelectronics, miniaturization, applications in automotive and other industries, micro sensors, micro actuation, micro accelerometers, microfluidics. Scaling laws in miniaturization, scaling laws – geometry, electrostatic forces, electromagnetic forces, electricity, heat transfer and fluid mechanics. Materials for MEMS and microsystems. Microsystems fabrication processes, photo lithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, deposition by epitaxy, etching, bulk manufacturing, surface micromachining, LIGA process. Microsystems – design and packaging, mechanical packaging of microelectronics, assembly of microsystems, packaging materials.

References:

1. Tai Ran Hsu, *MEMS and Microsystems - Design and Manufacturing*, Tata McGraw Hill, (1e), 2002.
2. Chang Liu, *Foundation of MEMS*, Pearson, (2e), 2012.
3. Marc J. Madou, *Fundamentals of Micro Fabrication-The Science of Miniaturization*, CRC Press, (2e), 2002
4. Wolfgang Menz, J. Mohr and Oliver Paul, *Microsystem Technology*, Wiley-VCH, 2008.

MC4142: MICRO-MANUFACTURING SYSTEMS [3 0 0 3]

Introduction, working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nano-manufacturing, industrial applications and future scope of micromanufacturing processes. Different instruments related to micro manufacturing such as microsensors, microactuators, microsystems. Working principles, machine construction, and applications of micromachining, nano-finishing, microjoining, microforming, micro-casting, micromolding, LIGA for micro/nano products and features, the diversified industrial applications of the micro-manufactured processes, and recent research trends in this area.

References:

1. Jain V. K., *Introduction to Micromachining*, Narosa Publishing house Pvt. Ltd., 2010.
2. Jain V. K., *Micromanufacturing*, CRC Press, 2012.
3. Jain V. K., *Advanced Machining Processes*, Allied Publishers Pvt. Ltd., 2014.
4. Mahalik N. P., *Micromanufacturing & Nanotechnology*, Springer Berlin Heidelberg, 2006.
5. Jackson J. M., *Microfacbrication & Nanomanufacturing*, CRC Press, 2005.

MC4143: NANOTECHNOLOGY [3 0 0 3]

Introduction to nanotechnology, bottom-up and top-down approaches, physical and chemical properties, methods of preparation of nanoparticles, carbon nanostructures and their applications, physical chemistry of nanosystems, micro electro mechanical devices and technologies - microsensors, MEMS fabrication processes and applications, microscale and nanoscale heat conduction, nanofluids preparation and characterization, nanomaterials used in energy and environmental applications and their properties, future development of micro actuators, nano-lithograghy, photoresist patterning, photolithography, electron beam lithography, production of polygon mirrors, optic fibers, future trends in nanotechnology.

References:

1. Charles P. Poole, *Introduction to Nanotechnology*, Wiley-Interscience, 2003.
2. Guozhong Cao, *Nanostructures & Nanomaterials*, Imperial College Press, 2004.
3. C B Sobhan, *Microscale and Nanoscale Heat Transfer*, Taylor and Francis, 2008.
4. Norio Taniguchi, *Nanotechnology*, Oxford University Press, 2008.
5. James J Allen, *MEMS Design*, Taylor and Francis, 2005.

MC4144 NON-LINEAR CONTROL SYSTEM [3 0 0 3]

Common Nonlinearities in Control Systems, State-space representation of nonlinear systems, Phase plane analysis, Lyapunov's Direct Method, Lyapunov Analysis of Non-Autonomous Systems, describing function analysis, Input-State Linearization of SISO, Input-Output Linearization, Stability Circle criterions, Sliding mode Control, Basic Concepts in Adaptive Control, Trajectory Control, back stepping.

References:

1. Khalil H.K., *Nonlinear Systems* (3e), Pearson Education India, 2014.
2. Marino R. and Tomei P., *Nonlinear Control Design - Geometric, Adaptive and Robust*, Prentice Hall, 1995.
3. Slotine J.J. and Li. W., *Applied Nonlinear control*, Pearson, 1991.

4. Isidori A., *Non-linear Control Systems*, Springer Verlag, 1999.

MC4145 PRODUCTION AND OPERATION MANGEMENT [3 0 0 3]

Forecasting: Importance and uses of forecasting, Type of forecasts, Correlation analysis and Seasonality, Forecast control. Product Development and Design: Factors affecting product development and design, Standardization, Capacity Planning: Factors affecting system capacity, Aggregate Planning: Pure and mixed strategies of aggregate planning, Material Requirement Planning: Product structure tree, Bill of Material. Machine Scheduling: Factors affecting job shop scheduling, Different priority sequencing rules, Determination of mean flow time, average job lateness and average number of jobs in the system, Line balancing, Inventory Control: Economic order quantity, Different inventory control models, Effect of quantity discount, Queuing Model: Introduction, Markov Chains and Markov Processes, Birth-Death Processes, Simple Queueing Models M/M/-/- Queues. Supply chain management: performance measures, centralized vs. decentralized systems, Outsourcing: Distribution and logistics in supply chains, Direct shipment/intermediate storage policies, Vehicle routing models, Third-party logistics, Service oriented architecture (SOA).

References:

1. Richard B. Chase, Nicholas J. Aquilano and Jacobs F. Roberts, *Production and Operations management,* Tata McGraw-Hill, New Delhi, 1999.
2. Eilon Samuel, *Elements of Production Planning and Control*, Universal Publishing Corporation, Mumbai, 1991.
3. Lee J. Krajewski and Larry P. Ritzman, *Operations Management*, Pearson Education, Singapore, 2005.
4. Gupta Prem Kumar and D. S. Hira, *Operations Research*, S. Chand & Co. Ltd., New Delhi, 2003.

MC4146 STATISTICAL QUALITY CONTROL METHODS [3 0 0 3]

Definitions of the term quality, Causes of variation, Patterns of variation, Frequency distribution, Measures of central tendency and dispersion, The Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables (X, R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes, Control charts for attributes (p ,np, c and u charts), Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, Acceptable quality level, Lot tolerance percent defective, Average outgoing quality, Average total Inspection, Average fraction inspected, Producers risk, Consumers risk, Acceptance sampling tables, Conventional and Statistical tolerance, Precision, Accuracy and Reproducibility of method of measurements, Quality costs.

References:

1. E. l. Grant, R. Levenworth, *Statistical Quality Control*, McGraw Hill Publications, 2005.
2. D.C. Montgomery, *Introduction to Statistical Quality Control*, John Wieley and Sons, 2005.
3. .M. S. Mahajan, *Statistical Quality Control*, Dhanpat Rai and Co. Pvt. Ltd., 2012.
4. J. M. Juran, F. M Gryna, *Quality Planning and Analysis*, Tata McGraw Hill Publications, 1995.
5. L. Bertrand, Hansen, *Quality Control- Theory and Applications*, Prentice Hall India, 1987.

MC4147 RELIABILITY ENGINEERING [3 0 0 3]

Fundamentals of reliability: Scope of reliability engineering, concept of bath tub curve, types of failure data, reliability estimations, constant failure rate models, time dependent failure rate models, concept of failure on demand. System reliability assessment: Reliability estimation of series/parallel/mixed/complex system configurations. Design for reliability: Capturing user's reliability requirements, reliability and/or redundancy allocation/optimization, design methods, FMEA/FMECA, reliability testing (burn-in testing, reliability assurance testing, reliability growth testing, accelerated life testing), fault tree analysis. Availability assessment: Point, mission and steady state availability, Markov modeling approach for availability estimation. Maintainability and maintenance: Maintainability assessment, and design for maintainability, concept of maintenance, types of maintenance, maintenance optimization. Warranty management: Types of warranty, reliability and warranty. Practical applications of reliability engineering to systems, products and processes: Case studies.

References:

1. P. O'Connor, *Practical Reliability Engineering*, John Wiley & Sons Inc. 2002.
2. G. K. Hobbs, *Accelerated Reliability Engineering: HALT and HASS*, Wiley, 2000.

3. C. Ebeling, *An Introduction to Reliability and Maintainability Engineering*, Waveland Pr. Inc., 2nd edition, 2009.
4. Bazovsky, *Reliability Theory and Practice*, Dover Publications, 2004.

MC4148 SYSTEM MODELLING AND SIMULATION [3 0 0 3]

Principles of modeling and simulation, modeling and simulation of mixed systems, transfer function, block diagram, state space representation of SISO, MIMO, modeling of dynamic systems, construction, analysis, practical applications, linear systems, methods of model order determination, impulse and frequency response methods, system identification, algorithms for parameter estimation, gradient algorithm, least square algorithm, ARX, ARMAX applications of LS and ARMA methods, regression methods, introduction to nonlinear modeling, identification NARMAX model, case studies UAV quad-rotor, hard discs, maglev systems, ball and beam systems.

References:

1. George Pelz, *Mechatronic Systems Modeling and Simulation with HDLs*, Wiley, 2003.
2. Devdas Shetty, Richard Kolk, *Mechatronics System Design*, (2e), Cengage Learning, 2010.
3. Benjamin C. Kuo, Farid Golnarghi, *Automatic Control Systems*, (8e), Wiley, 2009.
4. Jack W. Lewis, *Modeling of Engineering Systems PC-Based Techniques and Design Tools*, High Text Publications, 2000.
5. Ioan D. Landau, Gianluca Zito, *Digital Control Systems Design, Identification and Implementation*, Springer, 2006.

MC4149 VIRTUAL INSTRUMENTATION [3 0 0 3]

Architecture of a virtual instrument, Virtual instruments V/s Traditional instruments, Advantages of VI, Graphical programming, Creating Virtual Instruments using Lab VIEW-Loops, Arrays, Clusters, String and file I/O, Graphs, Case/Sequence Structures, Formula nodes, Local &Global Variables Data Acquisition, Common Instrument Interfaces, Current loop, System buses, Interface buses, VISA, Image acquisition and processing, Design of ON/OFF controller for a mathematically described processes using VI software.

References:

1. Jovitha Jerome, *Virtual Instrumentation Using LabVIEW*, PHI
2. Gary Johnson, *LabVIEW Graphical Programming*, (2e), MGH, 1997.
3. Jeffrey Travis, Jim Kring, *LabVIEW for Everyone: Graphical Programming Made Easy and Fun* (3e), Prentice Hall Professional.
4. S. Sumathi, P Surekha, *LabVIEW based Advanced Instrumentation systems*, Springer, 2007.
5. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, *LabVIEW Advanced Programming Techniques*, CRC Press, 2007

MC4150 PRODUCTION TECHNOLOGY [3 0 0 3]

Non-conventional Machining: EDM, IBM, ECM, ECG, CM, AJM, Wire cut EDM, USM, LBM, Gear and Thread Manufacturing: Different types of Threads manufacturing methods, and tools involved, Different gear forming and generating methods. Gears finishing processes. Powder Metallurgy: Production of metal powders, compaction and sintering. Polymers and Composites: Introduction to polymers and composites; plastic processing – injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites. Press Tool: Classification of presses, Classification of dies, cutting actions in dies, clearance, Methods of reducing cutting forces, Minimum Diameter of Piercing Centre of Pressure, Progressive Die design, scrap reduction, strip layout. Jigs and Fixtures: Differences between Jigs and Fixtures, Design principles, 3-2-1 location principle, Types of locators, Concept of work piece control, Geometric control.

References:

1. S. Kalpakjian, and Steven R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.
2. Ghosh, and Malik, *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.
3. P.C. Sharma, *A text book of Production Technology*, S. Chand and Company, 4th Edition, 2006.
4. R.K. Jain, *Production Technology: Manufacturing Processes, Technology and Automation*, Khanna Publishers, 17th Edition, 2011.
5. P. N. Rao, *Manufacturing Technology Volume-1*, Tata McGraw-Hill Education, 4th Edition, 2013.

MC4151 INDUSTRIAL ERGONOMICS [3 0 0 3]

Definitions of Ergonomics, Role of human factors engineer, Types of systems, Elements of man-machine system, System approach to human engineering, Information input and processing, Information theory, Sources and pathways of stimuli, Human sensorimotor system, Biases in decision making. Visual Displays, Quantitative and qualitative displays, Auditory displays, Biomechanics of motion, Functions of controls, Factors influencing design of control, Design of hand and foot controls, Use of Anthropometric data, Work surface, Location of component and general work place arrangement, Industrial fatigue, Causes and elimination of fatigue, Productivity and its improvement, Worker and working environment, Effect of light, colour, noise and vibration on performance.

References:

1. S. Mark, Sanders, J.C. Ernest, *Human Factors in Engineering and Design*, (7e), McGraw-Hill and Co, Singapore 1992.
2. R. S. Bridger, *Introduction to Ergonomics*, Taylor & Francis, (3e), 2008.
3. B. Pulat, Mustafa, *Fundamentals of Industrial Ergonomics*, (2e), Waveland Press Inc., Illinois, 1997.
4. M. I. Khan, *Industrial Ergonomics*, PHI Learning Pvt. Ltd., New Delhi, 2010.
5. S. Gavriel., *Handbook of Human Factors and Ergonomics*, (3e), Wiley, Hoboken, New Jersey, 2006.

MC4152: PROJECT MANAGEMENT [3 0 0 3]

Concept of project, Importance of project management, Project life cycle, Project management as an integrated approach, organizing projects within the functional organization, organizing projects as dedicated teams, Organizing projects within a matrix arrangement, Project manager and their attributes. Feasibility study: Pre-feasibility study, Technical feasibility, Managerial feasibility, Economic feasibility, financial feasibility, Cultural feasibility, Political feasibility, Environmental feasibility, Market feasibility, Steps of feasibility study. Estimating project times and costs: Factors influencing the quality of estimates, Costs associated with projects, estimating guidelines for times, costs and resources, Top-down approaches of estimation, Bottom-up approaches of estimation, and Hybrid approach of estimation. Risk management process: Risk identification, Risk Assessment - probability analysis, mitigating risk, avoiding risk, transferring risk, sharing risk, retaining risk, Contingency planning, Contingency funding and time buffers, Risk response control – change control management, Decision tree analysis, Numerical. Project scheduling: Bar charts and Milestone charts, Elements of network, Development of networks, Work Breakdown Structure (WBS), Critical Path Method, Program Evaluation and Review Technique, Network crashing, CPM updating, Numerical. Project audit and closure: Guidelines for conducting a project audit, Initiating and staffing, Data collection and Analysis, Audit reporting, Conditions for project closure, Evaluation of project team and members.

References:

1. C. Gary, E Larson, G. Desai, *Project Management – The Managerial Process*, Tata McGraw Hill Pvt. Ltd., New Delhi, 2013.
2. R. Paneerselvam, P. Senthilkumar, *Project Management*, PHI Learning Pvt. Ltd., New Delhi, 2010.
3. J. Meredith, S. Mantel, *Project Management - A Managerial Approach*, John Wiley & Sons, USA, 2012.
4. N. D. Vohra, *Quantitative Techniques in Management*, New Delhi, 2007.

MC4153 INFORMATION SYSTEM IN MANUFACTURING [3 0 0 3]

Manufacturing organizations and networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioral approach. Global e-business: Use of information systems in manufacturing functions, information system, organizations, and strategies Information Technology Infrastructure: IT Infrastructure and Emerging Technologies, Securing Information Systems, shop floor communications. Smart manufacturing and connected enterprise, ISA 95, Functional and physical sub-divisions, Global connected supply chain, mass customization, customer co-creation. Case studies of information systems for key manufacturing functions: Life cycle, supply chain, enterprise, quality, maintenance, materials, energy and sustainability information systems.

References:

1. T. O. Boucher and A. Yalçin, *Design of Industrial Information Systems*, 1st edition, Elsevier, 2006.
2. K. E. Kurbel, *Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies*, 1st edition, Springer, 2013.
3. R. Zurawski, *Integration Technologies for Industrial Automated Systems*, 1st edition, CRC Press, 2006.

MC4154 ARTIFICIAL INTELLIGENCE [3 0 0 3]

Introduction to AI and intelligent agents. Uninformed search, Heuristic search, stochastic search, adversarial search, game playing. Machine Learning: basic concepts, linear models, perceptrons, neural networks, naive Bayes, Decision trees, ensemble, logistic regression, and unsupervised learning. Constraint satisfaction problems, Markov decision processes, reinforcement learning. Logical agents, propositional logic, and first-order logic, planning, partial-order planning, Bayesian Networks, natural language processing, AI applications.

References:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence, A Modern Approach*, 3rd Edition, Pearson Education, 2015.
2. Kevin Knight, Eline Rich B. Nair, *Artificial Intelligence*, McGraw Hill Education 3rd edition 2012.
3. Dan W. Patterson, *Introduction to AI and ES*, Pearson Education, 2007.
4. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education Asia (2009).

MC4155 BUILDING AUTOMATION [3 0 0 3]

Overview of Digital Controller: Data Form used in computers, Microcomputer, Input / Output Unit, Processor Operation and Software, Sensors, Actuator, I/O devices, Field Controllers. Network and Communication protocols: Networking basics, Types of Networks- Serial and Parallel Communication, RS232 and RS 485 Interfaces, MODBUS protocol overview, BACnet protocol overview. Introduction to Building Management Systems: Buildings and Energy Management, Different systems in a building. Introduction to HVAC, StruxureWare for Building Operation. General BMS architecture: Introduction to HVAC and Optimal control methods for HVAC Systems: Important components of HVAC, HVAC Control systems and Direct Digital Control, AHU, Chillers, Zones, Air Distribution Systems, Field Devices, Schneider Controllers (PLC's). Lighting control systems: Strategies for energy management and lighting. Security and Safety Control Systems: Access Control-Introduction, Basic Components, Controller / Panel, Credentials, Reader, Locking Device, How it works / Operations, Type of Card/Readers, Anti-Pass back, Power Requirements, Videos (Digital Video Recorder), Types of Camera, Fire Alarm Systems - Sprinklers. System integration and convergence: Need for integration, interoperability and protocols, BMS integration case studies, iBMs, Compatibility of different internet Technologies and its application in BMS. Application of internet for Automation and Management: Web Based Automation, General Architecture, Web Enablement, Data Communication Energy Management: Overview on EMS, Energy Analysis/Audit. Green Buildings (LEED): Green Buildings Approach, Benefits of Green Buildings, Elements of Green Building Design, Leadership in Energy and
Environmental Design (LEED), LEED Case Study.

References:

1. V. K. Jain, *Automation Systems in Smart and Green Buildings*, published by Khanna Publishers, 2009.
2. Reinhold A, *Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security/access Control, Lighting, Building Management Programs*, 2009.
3. Ronnie J. Auvil, *HVAC Control Systems*, (2e), 2007.
4. Thomas L. Norman, *Integrated Security Systems Design: Concepts, Specifications, and Implementation* (1e) by CPP PSP CSC 2007.
5. Benantar, Messaoud, *Access Control Systems: Security, Identity Management and Trust Models*, Springer publication, 2005.

MC4156: ENERGY CONSERVATION, AUDIT AND MANAGEMENT [3 0 0 3]

Energy Conservation: Energy Scenario, Thermodynamic basis of energy conservation, Energy Conservation Act and policies, Energy conservation in HVAC systems and thermal power plants, Energy conservation in buildings and star ratings. Energy Audit: Definition, Energy audit-need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy audit instruments. Energy Management: Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy; Financial Analysis: Simple Payback, IRR, NPV, Discounted Cash flow.

References:

1. C.B. Smith, K.E. Parmenter, *Energy Management Principles*, (2e), Elsevier, 2015.
2. Albert Thumann, William J. Younger, *Handbook of Energy Audits*, (6e), The Fairmont Press Inc., 2003.
3. Frank Krieth, D. Yogi Goswami, *Energy Management and Conservation Handbook*, CRC Press, 2008.

4. Barney L. Capehart, Wayne C. Turner, *Guide to Energy Management*, (6e), Fairmont Press, 2008.
5. Barun Kumar De, *Energy Management, Audit and Conservation*, (2e),Vrinda Publications P Ltd. 2014.

MC4157 MACHINE TOOL TECHNOLOGY [3 0 0 3]

Types of motion in cutting, cutting speed, feed, depths of cut in machining, cutting tools classification, nomenclature of single point cutting tool, difference between orthogonal and oblique cutting, mechanism of metal cutting, types of chips, chip breakers, forces acting on a tool, merchant circle diagram, velocity relations, specific energy in cutting, tool wear, tool life factors, Taylor's tool life equation, tool wear mechanisms, heat distribution in metal cutting, measurement of temperature in metal cutting, lathe tool dynamometer, cutting fluids selection and applications, cutting tool materials, specifications for inserts and tool holders. CNC tooling, tool presetting, automated tool & pallet changing, work holding, cutting process parameter selection, jigs and fixtures, types of clamping devices, principles of clamping.

References:

1. Milton C.Shaw, *Metal Cutting Principles*, (2e), Oxford University Press, 2000.
2. Kempster, *Jigs and Fixtures*, (3e), Mark Howard Publications, 2004.
3. Steve Krar, Arthur Gill and Peter Smid, *MachineTool Technology Basics*, (2e), Industrial Press Inc., U.S, 2012.
4. Sharma. P. C, *A Text Book of Production Engineering*, (7e), S. Chand Publishers, New Delhi, 2008.

MC4158 MACHINE VISION AND IMAGE PROCESSING [3 0 0 3]

Image Acquisition and Analysis: Vision system components, Image acquisition and analysis, Image digitization, Image enhancement, restoration, Segmentation, Morphological Operations, image representation and analysis, color image processing. 3D Vision: Camera and optics, Perspective Projection Geometry Rotation and translation matrix, Pinhole camera model, Calibration methods, Intrinsic and Extrinsic Camera Parameters, Stereovision, Stereo correspondence Algorithms, Epipolar Geometry, Essential and fundamental matrix, 3D Reconstruction. Motion Estimation and Tracking: Optical □ow estimation, Object tracking with Kalman filtering. Basic idea of localization employing passive markers. Case Studies/Application: Basic color detection, Face recognition, Vehicle tracking, applications using computer vision toolbox and image processing toolbox of MATLAB.

References:

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, (3e), Pearson Education, 2008.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis and Machine Vision*, (2e), 1998.
3. Boguslaw Cyganek & J. Paul Siebert, *An Introduction to 3D Computer Vision Techniques and Algorithms*, (1e), Wiley, 2009
4. David A. Forsyth Jean Ponce, *Computer vision: A modern approach*, Pearson Education Limited.
5. E.R. Davies, Royal Holloway, *Machine Vision: Theory, Algorithms and Practicalities*, (3e), University of London, 2004.

MC4159 DYNAMICS AND CONTROLS OF MECHATRONICS SYSTEMS [3 0 0 3]

Industrial feedback controllers, PID controllers, tuning methods, frequency response approach, computational optimization, modified PID scheme. Introduction to state space analysis - state space representations, Eigen vectors and Eigen values, transfer functions, state space modeling. Control system design in state space, solution of LTI state equation, controllability and observability, state feedback controllers, state observers Lyapunov stability analysis, quadratic optimal control. Types of nonlinearity, describing functions phase plane method, linearization techniques, MATLAB simulation, state space modeling, feedback controllers, observers, regulator problems.

References:

1. Ogata K., *Modern Control Engineering*, (5e), Pearson Prentice Hall, 2005.
2. Karl J. Astrom, *Feedback systems- An Introduction for Scientists and Engineers*, Princeton University Press, 2008.
3. Norman S. Nise, *Control Systems Engineering*, (6e), John Wiley & Sons, Inc, 2011.
4. Stanley M. Shinners, *Modern Control Systems, Theory and Design*, John Wiley & Sons, Inc, 2009.
5. Gopal M., *Modern Control System Theory*, (2e), New Age International Ltd, 2005.

MC4160 ELECTRIC VEHICLE MACHINES AND DRIVES [3 0 03]

Overview of EV Technologies-Motor Drive Technology, Energy Source Technology, Battery Charging Technology, Vehicle-to-Grid Technology, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle. DC Motor Drives – System Configurations, DC Machines, DC–DC Converters, Soft-Switching DC–DC Converter Topologies, DC Motor Control, Regenerative Braking, Design Criteria of DC Motor Drives for EVs. Induction Motor Drives-System Configurations, Induction Machines, Inverters for Induction Motors, Induction Motor Control, Design Criteria of Induction Motor Drives for EVs. Permanent Magnet Brushless Motor Drives- System Configurations, PM Brushless Machines, PM Brushless Motor Control, Design Criteria of PM Brushless Motor Drives for EVs, Switched Reluctance Motor Drives- SRM Machines, SR Converters, Comparison of SR Converters for EVs, SR Motor Control, Design Criteria of SR Motor Drives for EVs, Machine Initialization, Planetary-Geared SR Motor Drive, Outer-Rotor In-Wheel SR Motor Drive. Integrated-Starter-Generator Systems -System Configurations, ISG Machines, ISG Operations, Cranking, Electricity Generation, Idle Stop-Start, Power Assistance. Planetary-Geared Electric Variable Transmission Systems: Input-Split PG EVT Systems, Compound-Split PG EVT Systems, Design Criteria of PG EVT Systems, PM Synchronous PG EVT System Configuration. Double-Rotor Electric Variable Transmission Systems-Double-Rotor Machines, Basic Double-Rotor EVT Systems, Advanced Double-Rotor EVT Systems, Axial-Flux DR EVT System, Magnetless DR EVT System, Design Criteria of DR EVT Systems, Design Example of DR EVT Systems. Potential Applications of DR EVT Systems in HEVs.

References:

1. K T Chau, Electric Vehicle Machines and Drives- Design, Analysis and Application, (1e) John Wiley & Sons, 2015.

MC4161 COMPUTER NETWORKS AND COMMUNICATION PROTOCOLS [3 0 0 3]

Introduction to reference models, data communication, network architecture, basics of OSI, and TCP/IP reference models. Transmission media, FDM, TDM and CDMA, Frame Relay and ATM switching, ISDN, Local area network protocols, IEEE standards for LAN. Data link layer design, functions and protocols, link layer, error detection and correction techniques, Ethernet, hubs and switches, PPP, Network layer, Transport layer: connectionless transport-UDP, FTP, Electronic Mall in the internet, P2P file sharing, HTTP, quality of services: ATM Differentiated service model, flow identification, scheduling, factors affecting QoS parameters and service categories, network management, protocol, SNMP, CMIP, concept of traffic and service. Voice and video data, ATM Traffic, Traffic contracting.

References:

1. Andrew S. Tanenbaum, *Computer networks*, 5th edition, PHI, 2010
2. William Stallings, *Data and computer communications*, 7th edition, Prentice Hall of India Pvt. Ltd. 2004
3. James F. Kurose, Keith W. Ross, *Computer networking (A top-down approach featuring the internet)*, 3rd edition, Pearson Education, 2005
4. Charle Kaufman, Radia Perlman, Mike Specines, Uyless Black, *Computer networks: Protocols standards and interfaces*, Prentice Hall of India Pvt. Ltd. 2010

MC4162: MACHINE LEARNING [3 0 0 3]

Introduction: Basic concepts-Supervised Learning, Discriminative Algorithms. Supervised learning: Supervised learning setup, Linear Algebra, Weighted Least Squares, Logistic Regression, Newton's Method, Perceptron, Exponential Family, Generalized Linear Models, Gaussian Discriminant Analysis, Naive Bayes, and Laplace Smoothing. Support Vector Machines, Support Vector Machines, Kernels, Bias-Variance tradeoff. Regularization and model/feature selection, Tree Ensembles, Neural Networks: Basics, Evaluation Metrics, K-means. Mixture of Gaussians. Expectation Maximization, Factor Analysis, Principal Component Analysis. Independent Component Analysis, MDPs. Bellman Equations, and Reinforcement learning and control: MDPs. Bellman equations, Value iteration and policy iteration, linear quadratic regulation (LQR), LQG, Q-learning. Value function approximation.

References:

1. Ethem Alpaydin, *Introduction to Machine Learning*, (3e), MIT Press, 2014
2. Christopher Bishop, *Pattern Recognition and Machine Learning (Information Science and Statistics)*, Springer; (1e). 2006. Corr. 2nd Print, 2011.
3. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Chapman and Hall/CRC, (2e), 2014.
4. Tom M. Mitchell, *Machine Learning*, McGraw Hill Education 2013.

5. Andreas C. Muller & Sarah Guido, *Introduction to Machine Learning with python: A guide for Data Scientists*, O'Reilly (3e), 2017.

MC4163: INDUSTRIAL AUTOMATION [3 0 0 3]

Data loggers, Data Acquisition Systems, Direct Digital Control, SCADA, Programmable Logic Controller, Ladder logic Programming, PID functions, analog PLC operation, Alternate Programming Languages, PLC Maintenance, Interface and Backplane Bus Standards, Field bus, HART protocol, Smart transmitters, Valves and Smart actuators, MODBUS, Profibus, IEC 1158-2 Transmission Technology, Distributed Control Systems, Local Control Unit, Communications for DCS, Displays Engineering interfaces.

References:

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e). 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., 1986.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, (2e), 1997.

MC4164: AUTOMATED MANUFACTURING SYSTEM [3 0 0 3]

Overview of Manufacturing and Automation: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Additive Manufacturing : Process Chain for Additive Manufacturing Processes, Rapid Prototyping Data Formats, Liquid Based Process, Rapid Freeze Prototyping, Solid Based Process, Powder Based Process, Rapid Tooling Application in design, engineering, analysis and planning, Applications. Subtractive Manufacturing: Computer numerically controlled machining, Numerical control in Non-Traditional Machining, Adoptive control Machining system. Basics of CNC programming (Simulation). Flexible Manufacturing System: Group Technology, Cellular Manufacturing, Quantitative Analysis of Cellular Manufacturing (Rank order Clustering), Flexible Manufacturing system (FMS), Quantitative analysis of FMS (Bottleneck model), Computer Aided Process Planning (CAPP). Product Life Cycle and Data Management (PLDM): Components of PLM, phases of PLM, PLM feasibility study, PLM visioning. PLM Strategies, Strategies for recovery at end of life, recycling. Product Data Management systems and importance, barriers to PDM implementation.

References:

1. C.K. Chua, K.F. Leong, C.S. Lim, *Rapid Prototyping: Principles and Applications*, (3e), 2010.
2. Gibson, I, Rosen, D W., and Stucker, B., *Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer, 2014.
3. Groover Mikell P, Automation, *Production Systems, and Computer Integrated manufacturing*, (4e), Prentice Hall of India. New Delhi, 2016.
4. Kalpakajain, *Manufacturing Engineering and Technology*, (4e), Addison Wesley, New York, 2014.
5. Saaksvuori, Antti, Immonen, Anselmi, *Product Lifecycle Management*, (2e), Springer-Verlag Berlin Heidelberg, 2005.

OPEN ELECTIVES

MC2080: INTRODUCTION TO ROBOTICS [3 0 0 3]

Introduction to robotics, sensors, actuators, transmission and drives used in robotic systems, power, torque, force calculations for robotic systems, degrees of freedom (DOF), robot configuration, spatial resolution, accuracy and repeatability, robot specifications, structure of robotic system, robot kinematics, robot control, trajectory planning, mobile robotics, features of future robots, robot programming, interactions of robots with other technologies, characteristics of future robot tasks, robots in construction trades, coal mining, utilities, military and fighting operations, under sea robots, robots in space, service industry and similar applications.

References:

1. M. Vidyasagar Mark W. Spong, *Robot Dynamics and Control*, Wiley India Private Limited, 2008
2. S. R. Deb, *Robotics Technology and Flexible Automation*, 2nd Edition, McGraw Hill Education, 2012
3. John J. Craig, *Introduction to Robotics - Mechanics and Control*, Pearson Education International, 2004.
4. FU, *Robotics Control Sensing Vision And Intelligence*,1st Edition, McGraw Hill Education,2010

MC2081: MECHATRONICS SYSTEM [3 0 0 3]

Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors and Transducers: Displacement Sensor, Strain gauges, Force, Motion sensors, Proximity sensors, Light sensors, tactile sensors, Piezoelectric sensors, Temperature sensor DRIVES AND ACTUATORS: relays, DC and BLDC Motor, Servo motor, stepper motors, Data Acquisition and Translation: Signal conditioning, amplifiers, filters, ADC, DAC Data Presentation System: LED, LCD, Controllers and Algorithms.

References:

1. D. Shetty & R. Kolk, Mechatronics System Design, *PWS Publishers*
2. Mechatronics – HMT, *Tata McGraw Hill Publishing Company Ltd, 1998.*
3. C. R. Venkataramana, Mechatronics, *Sapna Book house, Bangalore, 2001.*
4. Robert H. Bishop, Mechatronics: An Introduction, *Taylor & Francis Group*

MC2082: AUTOMATION IN INDUSTRIAL SYSTEM [3 0 0 3]

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines. Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. Automated Manufacturing Systems: Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Technologies in Automation.

References:

1. Krishna Kant, *Computer Based Industrial Control*, EEE-PHI,2nd edition,2010
2. Viswanandham, *Performance Modeling of Automated Manufacturing Systems*, PHI, 1st edition, 2009.
3. M. P. Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education.5th edition, 2009.

MC2083: ARM ARCHITECTURE BASED SYSTEM DESIGN [3 0 0 3]

Introduction to ARM embedded systems, RISC and ARM design philosophy, Embedded system hardware and software, ARM processor fundamentals, ARM processor families, Architecture revisions, Pipeline, Registers and Exceptions, Interrupts and vector table. Introduction to ARM instruction set, Data Processing Instructions, Branch Instructions, Load and Store instructions, Software Interrupt instructions and Conditional execution. Optimizing ARM Assembly Code, Profiling and cycle counting, instruction scheduling, Exception and Interrupt Handling, Interrupts, Memory Management Units, Moving from an MPU to an MMU, How Virtual Memory Works, Case studies.

References:

1. Steve Furber, *ARM System-on-Chip Architecture*, Addison Wesley,(2e), 2000.
2. Andrew N Sloss, Dominic Symes, Chris Wright, *ARM system developers guide: Designing and optimizing system software*, Elsevier, 2004
3. Marilyn Wolf, *Computers as Components: Principles of Embedded Computing System Design*, Morgan Kaufmann Publishers(4e), 2016
4. Joseph Yiu, *The definitive guide to ARM Cortex M3 and Cortex M4 Processors*, Elsevier(3e), 2013
5. Peter Marwedel, *Embedded System Design*, Springer(2e),2011

MC3080: HYDRAULIC & PNEUMATIC SYSTEMS [3 0 0 3]

Pneumatic systems, structure and signal flow, compressors, actuators and control valves, single acting and double acting cylinders, manual pneumatics, single and multiple actuators, limit switches, proximity sensors, electro pneumatics and design of electro pneumatic circuits, direction control valves, relay control systems, timers, counters, pressure control valves, closed loop pneumatics and Flow control valves. Hydraulic systems, physical principles of oil hydraulics, hydraulic actuators, valves and accessories, hydraulic power pack, types of hydraulic pumps, accumulator, Filters, hydraulic circuits, regenerative, meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits, proportional hydraulics and servo hydraulics.

References:

1. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
2. P. A. Andrew, *Hydraulics and Pneumatics*, Elsevier Science &Technology Books, (3e) 2011.

3. D. Scholz., *Proportional Hydraulics*, Festo Didactic GMBH & Co, Germany, 2002.
4. S. R Mujumdar, *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

MC3081: QUALITY CONTROL & MANAGEMENT [3 0 0 3]

Quality Control: Meaning of quality and need of quality control, Assignable and non-assignable causes of variation, normal curve and other frequency distributions. Need of SQC, Statistical tolerances. Statistical methods for Quality Control in Manufacturing: An introduction to statistics for Quality applications, Process capability, Theory of control charts, control limits and specification limits; Control charts for variable. X, R charts, control charts for attributes, p, np charts, c-charts and u-charts. Study of special control charts; Moving range and moving average charts, CUSUM charts. Acceptance sampling: Some fundamental concepts in acceptance sampling, O.C. curve, sampling terms, sampling plans with different criteria. Quality Management: Introduction to Total Quality Control, Quality Assurance, ISO-9000, and Quality Control tools, Kaizen, Benchmarking, cost of poor quality, Philosophies of Quality gurus like W.E. Deming, J.M. Juran, K. Ishikawa and Philip B. Crosby. Reliability: Basic concept, definition and its importance, Measures of Reliability, System Reliability: Series, Parallel systems.

References:

1. B. H. Dale, *Total Quality Management*, Pearson Education, 2018
2. E. L. Grant E, R. Levenworth , *Statistical Quality Control*, McGraw Hill Publications, 2005.
3. M. S. Mahajan , *Statistical Quality Control*, Dhanpat Rai, 2006

MC3082: RELIABILITY AND MAINTENANCE ENGINEERING [3 0 0 3]

Introduction to Reliability Availability and Maintainability (RAM), Development of RAM Engineering, Reliability Availability and Maintainability utilization factors, down time consequences. Reliability engineering fundamentals and applications, Reliability functions, typical Hazard functions, Mean time to failure, Cumulative Hazard function, Application of Probability distribution function in Reliability evaluation combinational Aspects of Reliability, Markov models optimization of system Reliability, Heuristic Methods applied to optimal system Reliability. Maintainability: Definition and application of Maintainability Engineering, Factors affecting Maintainability. Maintainability design criteria, operating and down time categories, Maintainability and its quantification, Mean time to activity restore an equipment, Mean Maintenance man hours, Mean time for corrective and Preventive Maintenance, Replacement Policies. Availability, types of Availability, approaches to increase equipment Availability.

References:

1. C.E. Ebeling, *An Introduction to Reliability and Maintainability Engineering*, McGraw Hill Publication, 2005.
2. S.S. Rao, *Reliability Engineering*, Pearson Publication, 2016.
3. K.C. Kapoor and L.R. Lamberson, *Reliability in Engineering Design*, John Wiley Publication, 2015.
4. E. Balagurusamy, *Reliability Engineering*, McGraw Hill Publication, 2018.

MC3083: BIOMEDICAL INSTRUMENTATION [3 0 0 3]

Fundamentals of Medical Instrumentation, Physiological Transducers, Half- cell potential, Types of electrodes, Electrode, Electrolyte model, Amplifiers for biomedical instrumentation; Physiological Signals & Measurements: Basics of ECG, EMG, EEG, blood pressure & blood flow and the instrumentation for measuring these signals; Cardiac Pacemakers: Types of pacemakers, Modes of triggering, Pacemaker power supplies, pacemaker codes; Defibrillators: AC and DC defibrillators, principles of tomography; Diathermy, MRI ,Electrical Hazards & Safety: Safety code standards, Micro and Macro shock and its physiological effects, Methods of electrical safety.

References:

1. John G Webster, *Medical Instrumentation Applications and Design*, John Wiley and Sons, New York, (3e), 2011.
2. R S Khandpur, *Handbook of Biomedical Instrumentation*, McGraw Hill, Delhi, (3e), 2014.
3. L A Geddes, L E Baker, *Principles of Applied Medical Instrumentation*, Wiley India, New Delhi, (3e), 2008.
4. Richard Aston, *Principles of Biomedical Instrumentation and Measurement*, Merrill, New York, 1991.
5. Joseph J Carr, John M Brown, *Introduction to Biomedical Equipment technology*, Prentice Hall, New Jersey, (4e), 2003.

MC3084: SENSORS &TRANSDUCERS [3 0 0 3]

Functional elements of an Instrument, Types of transducers, Null and Deflection methods, Input/output configurations, characteristics, types of errors, Resistive, Capacitive, Inductive transducers, Hall Effect sensors, magneto elastic transducers, solid state sensors, eddy current transducers, Piezo Electric transducers, pH Measurement, Semiconductor sensors, photo electric transducers, CCD, shaft encoder and decoders, optical encoders, flow sensors, gas sensors, density, viscosity, moisture and humidity measurements.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. DVS Murthy, Transducers & Instrumentation, PHI, (2e), 1999.
3. B.G. Liptak, Process Measurement & Analysis, Chilton Book Company, (4e), 2003.
4. A.K Sawhney, A course in Electrical and Electronic Instrumentation Measurements, (7e), Dhanpat Rai & Co, 2002.
5. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.

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