MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

ACADEMIC PROGRAM HAND BOOK
M.Tech./MCA 2020

2020

Founder and Builder of Manipal

Manipal is a place born out of one man's dream - Dr. Tonse Madhav Ananth Pai. It is a testimony to the fact that no matter how big a dream is, it can always turn into reality. The once barren hillock is now India's largest education township with more than 24 institutions of learning.

Manipal Academy of Higher Education is the result of the single-minded dedication of the founder Dr. T. M. A. Pai. It was his vision to see the bare hilltop of Manipal transformed into one of the premier centres of learning.

Manipal Academy of Higher Education was founded on one principle; one unshakeable belief - that it must make available the best of education to its students. The last 62 years, have seen institutes at Manipal taking meticulous, small steps to build reservoirs of intellectual wealth and academic excellence.

In the process, Manipal Academy of Higher Education has created some of the country's best institutes across diverse streams like medicine, dentistry, engineering, pharmacy, hotel management and communication. MAHE has been recognised as an 'Institution of Eminence' by MHRD, Govt. of India.

Each institution at Manipal Academy of Higher Education is geared to meet the same demanding standards to create great professionals and citizens by inspiring them in many ways.

“The wealth of education is something which you cannot exhaust by giving”

Padma Shri awardee Dr. T. M. A. Pai

History of the Institute

Manipal Institute of Technology (MIT), one of the premier engineering institutes in India, was among the first self-financed engineering colleges in the country. It was started in 1957 by Padmashee awardee late Dr. T. M. A. Pai, as Manipal Engineering College with an undergraduate course in Civil Engineering.

In 1965, the institute got affiliated to the University of Mysore from Karnataka University. In 1974, it was renamed as Manipal Institute of Technology (MIT). In 1980 it got affiliated to the University of Mangalore. After the creation of the Visveswaraiah Technological University (VTU), MIT along with a number of other engineering colleges in the state got affiliated to the VTU in 1998. As the Manipal Academy of Higher Education (MAHE) had acquired a Deemed University status, MIT became a constituent institution of MAHE in May 2000. In 2003, MIT obtained full academic autonomy and adopted credit system with 10 point grading. With a total student strength of over 9000, MIT has emerged as the largest institute of the University.

MIT currently offers undergraduate programs (B.Tech.) in 17 disciplines and postgraduate courses (M.Tech. / MCA) in 25 different streams and Doctoral programs (Ph.D) in all streams of engineering, basic sciences, humanities and management. Academic programs offered by the institute are approved by AICTE and have been accredited by the National Board of Accreditation (NBA). The institution plays a vital role in producing world-class engineers tuned to the demands of a fast changing global village.

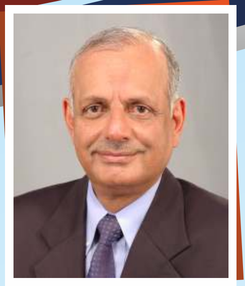
VISION

"Excellence in Technical Education through Innovation and Teamwork"

Leading the way...

Manipal Academy of Higher Education

Dr Ramdas M Pai
Chancellor



Dr H S Ballal
Pro Chancellor

Lt. Gen. (Dr) M D Venkatesh
Vice Chancellor

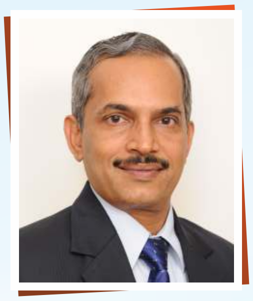
Dr P L N G Rao
Pro Vice Chancellor
Quality Assurance

Dr Dilip G Naik
Pro Vice Chancellor
Mangaluru Campus

Dr Poornima Baliga B
Pro Vice Chancellor -
Faculty of Health Sciences

Dr Abdul Razzak M S
Pro Vice Chancellor
Melaka Campus, Malaysia

Dr C S Thammaiah
Pro Vice Chancellor
Corporate Academia Engagement



Dr Narayana Sabhahit
Registrar

Dr Vinod V Thomas
Registrar Evaluation

Administrators

Manipal Institute of Technology

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ACADEMIC REGULATIONS

1. ACADEMIC PROGRAMMES

1.1 *The institute offers Bachelor of Technology (B.Tech.), Master of Technology (M.Tech.) and Master of Computer Applications (MCA) programmes of MAHE.*

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

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

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

2. ADMISSION PROCEDURE

2.1 *Undergraduate Programme (B.Tech.):*

Eligible students are admitted on the basis of the rank obtained in the All India MAHE Online Entrance Test. Seats are reserved for NRI / Foreign students.

2.2 *Post Graduate Programmes (M.Tech. / MCA):*

Eligible students are admitted on the basis of the rank obtained in the All India MAHE Online Entrance Test. Seats are reserved for NRI / Foreign students.

3. ELIGIBILITY FOR ADMISSION

3.1 *Undergraduate Programme (B.Tech.):*

3.1.1 Pass in 10+2 or equivalent with Physics, Mathematics and English as compulsory subjects along with Chemistry / Biotechnology / Biology / any technical vocational subjects as optional; with a minimum of 50% marks taken together in Physics and Mathematics and any one of the optional subjects.

3.1.2 Holders of three years Diploma in Engineering awarded by the Board of Technical Education in Karnataka or equivalent / B.Sc. Degree with Mathematics as one of the subjects; securing an aggregate of at least 50% marks are eligible to join Third semester under lateral entry scheme.

3.1.3 Eligible NRI / Foreign students are admitted based on their qualifying examination performance.

3.2 *Post Graduate Programmes:*

3.2.1 M.Tech.:

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

3.2.1.2 Eligible NRI / Foreign students are admitted based on their qualifying examination performance.

3.2.2 M.Tech. (Part-time):

3.2.2.1 Faculty/Staff sponsored from MAHE only are eligible to do part-time M.Tech. programme.

3.2.2.2 Duration of M.Tech. (Part time) programme is 6 semesters.

3.2.3 MCA:

3.2.3.1 A bachelor's degree in Computer Applications / Computer Science / Information Technology with a minimum of 50% aggregate marks in the qualifying examination.

3.2.3.2 Eligible NRI / Foreign students are admitted based on their qualifying examination performance.

4. ACADEMIC PROCESS

4.1 *Registration:*

4.1.1 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:*

4.2.1 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 *Academic Term:*

4.3.1 Semester system of 16 weeks duration with continuous and comprehensive assessment is followed.

4.3.2 Each semester has a specified course structure.

4.3.3 The first year B.Tech. course structure is common to all branches of Engineering.

4.3.4 The medium of instruction for all courses offered is English.

4.3.5 Eighth semester of B.Tech. programme, fourth semester of MCA programme as well as third & fourth semesters of M.Tech. programme is fully dedicated to project work.

4.4 *Course Numbering:*

4.4.1 The courses offered by each Department are coded with 3 letters indicating the department offering the course followed by 4 digits.

4.4.2 First digit indicates the level, second digit indicates semester offered ('1': offered in ODD; '2': offered in EVEN; '0': offered in BOTH) and the last two digits indicate the serial number.

4.4.3 The following codes are used for different departments:

DEPARTMENT	CODE
Aeronautical and Automobile Engineering	AAE
Biomedical Engineering	BME
Biotechnology	BIO
Chemical Engineering	CHE
Civil Engineering	CIE
Computer Science and Engineering	CSE
Electronics and Communication Engineering	ECE
Electrical and Electronics Engineering	ELE
Information and Communication Technology	ICT
Instrumentation and Control Engineering	ICE
Mechanical and Manufacturing Engineering	MME
Mechatronics	MTE
Media Technology	MED
Physics	PHY
Chemistry	CHM
Mathematics	MAT
Humanities and Management	HUM
Computer Applications	MCA

4.5 *Credit Based System:*

4.5.1 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 Hour Lecture / Tutorial per week is assigned 1 Credit, where as for practical courses 3 contact hours per week is assigned 1 Credit.

4.5.2 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.

4.5.3 Promotion of a student to higher semesters is based on securing a prescribed minimum number of credits.

4.6 *Assessment:*

4.6.1 The academic performance of a student is assessed by the course instructor/s concerned.

4.6.2 The student performance in each theory course is evaluated out of 100 marks, of which 50 marks are for in-semester assessments and 50 marks are for end-semester assessments.

4.6.3 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.

4.6.4 The student performance in laboratory courses is also evaluated out of a maximum of 100 marks, and is based on in-semester assessment of 60 marks and examination conducted for 40 marks.

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

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

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

4.7 *Attendance Requirements:*

4.7.1 All students must attend every lecture, tutorial and practical classes.

4.7.2 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.

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

4.8 *Grading System:*

4.8.1 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

4.8.2 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

4.8.3 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

4.8.4 Evaluation of Project Work Dissertation/ Thesis

4.8.4.1 Eighth Semester B.Tech.:

4.8.4.1.1 B.Tech. student shall carry out a Project Work for a minimum of 16 weeks duration.

4.8.4.1.2 The Project Work can be carried out in the institution / industry / research laboratory or any other institution where facilities exist with approval of the parent Department.

4.8.4.1.3 There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. This evaluation will be done by the department concerned and will be out of 100 marks.

4.8.4.1.4 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.

4.8.4.1.5 In case of external projects, the feedback of the external guide shall be considered during evaluation.

4.8.4.1.6 The end-semester evaluation of the project work is out of 300 marks.

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

4.8.4.2 Second year M.Tech. / Fourth Semester MCA:

4.8.4.2.1 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.

4.8.4.2.2 There will be a mid-term evaluation of the work after about 18 weeks by the department concerned.This evaluation will be out of 100 marks.

4.8.4.2.3 In the case of the Fourth Semester MCA students, the minimum project duration is 16 weeks and there will be a mid-term evaluation by the department concerned after about 8weeks.

4.8.4.2.4 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.

4.8.4.2.5 In case of external projects, the feedback of the external guide shall be considered during evaluation.

4.8.4.2.6 The end-semester evaluation of the project work is out of 300 marks.

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

4.9 *Class Committee:*

4.9.1 A class committee headed by the Associate Director (Academics) is formed for the first year B.Tech. progamme. The section coordinators, course coordinators and student representatives of all sections will be members of this committee.

4.9.2 For III to VIII Semester of B.Tech. progamme and for every semester of M.Tech. & M.C.A. progamme, 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.

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

4.9.4 Functions of the Class Committee:

4.9.4.1 The class committee will meet thrice in a semester.

4.9.4.2 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.

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

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

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

4.9.4.6 The Associate Director (Academics) will declare the results after processing.

4.10 *Section Committee:*

4.10.1 Each section of the first year 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.

4.10.2 The Section Coordinator will be a senior faculty member who teaches at least one subject for that section. The Section Coordinators will be nominated by the Associate Director (Academics), who will administer the functioning of all the Section Committees.

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

4.11 *Faculty Advisors:*

4.11.1 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.

4.11.2 Faculty Advisor for a particular batch will continue till the regular students complete the programme.

4.12 *Promotion to Higher Semesters:*

4.12.1 B.Tech. Programme:

4.12.1.1 Promotion of a student from an even semester to the next higher (odd) semester is subject to securing the minimum academic performance specified.

4.12.1.2 To be eligible for promotion to the third semester, a student should have earned a minimum of 26 credits at the end of the second semester.

4.12.1.3 To be eligible for promotion to the fifth semester, a student should have earned a minimum of 72 credits at the end of the fourth semester.

4.12.1.4 To be eligible for promotion to seventh semester, a student should have earned a minimum of 118 credits at the end of the sixth semester.

4.12.2 M.Tech. Courses:

4.12.2.1 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

4.12.2.2 A part-time M.Tech student can start the project work at the beginning of the third year, but he/she has to earn all the credits of course work, before he/she is permitted to submit the project thesis

4.12.3 M.C.A. Course:

4.12.3.1 Promotion of a student from second semester to third semester is subject to securing a minimum of 30 credits at the end of the second semester.

4.13 *Academic Probation and Termination of the registration to the programme:*

4.13.1 A student who is not eligible for promotion from an even semester to the next higher 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.

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

4.13.3 The student put on academic probation shall be periodically monitored and mentored by the faculty advisor. He/she can rejoin the academic programme after fulfilling the academic requirements as in 4.12 at the end of the academic probation.

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

4.14 *Rejoining a Programme:*

A student who discontinues the academic programme for any reason and rejoins 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 rejoining the programme.

4.15 *End-Semester Examination:*

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

4.15.2 A student should have appeared for the end-semester examination of the prescribed course of study to be eligible for the award of a passing grade in the course.

4.15.3 Only students with attendance $\geq$ 75 % will be permitted to appear for the end semester examination.

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

4.15.5 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 that course.

4.15.6 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/ Associate Director (Academics).

4.15.7 If a student is eligible for but fails to appear in the end-semester examination due to valid reasons, he/she will be awarded an 'I' grade (incomplete) on the grade sheet. However, it needs approval of Associate Director (Academics).

4.16 *Make-up examinations:*

4.16.1 Make-up examinations will be held at the end of the semester break to help the students who have got F/I grade in the courses offered during the semester.

4.16.2 The cut-off marks for grades in the make-up examination will be same as those in the regular end-semester examination.

4.16.3 However, for students who have once failed (F grade) in any course, a maximum of C grade only will be awarded in subsequent examinations irrespective of their performance.

4.16.4 Those who miss regular examinations due to valid reasons (I grade) will be allowed to retain whatever grade they secure in make-up examinations.

4.17 *Re-valuation of answer scripts:*

4.17.1 A student may apply for the revaluation of end-semester examination by submitting an application along with the specified fee.

4.17.2 Those who apply for revaluation will be able to see their answer papers along with the scheme of evaluation on a scheduled date.

4.17.3 The fee will be refunded in case of any change in grade after revaluation.

4.18 *Re-registration of courses:*

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

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

4.18.3 Students are allowed to register for a maximum of 36 credits in a given semester.

4.18.4 Students are eligible to get actual grades in re-registered courses.

4.19 *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.

4.20 *Eligibility for the Award of Degree:*

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

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

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

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

4.20.2 Total number of credits required for obtaining:

4.20.2.1 B.Tech. - 170*

* Credit used for CGPA computation: 157. Open electives and industrial training are to be graded and excluded from GPA/CGPA computation.

4.20.2.2 M.Tech. - 75

4.20.2.3 MCA - 80

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

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

4.21 *Audit Courses:*

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

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

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

4.22 *Minor Specialization:*

4.22.1 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.

4.22.2 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 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 Associate Director (Academics), at the end of the second semester.

5.3 Merit list will be prepared based on the CGPA after the declaration of second semester results.

5.4 Only students who have passed in all the subjects of I & II semesters are eligible for change of branch.

5.5 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.

5.6 *Mutual change of branch is not permitted.*

6. TRANSFER OF CREDITS

The courses credited elsewhere, in Indian/Foreign University/Institutions/Colleges/certified MOOC by students during their study period at MIT Manipal may count towards the credit requirements for the award of degree. The credit transferred will reduce the number of courses to be registered by the student at MIT. The guidelines of such transfer of credits are as follows:

6.1 *B.Tech student with consistent academic performance and CGPA ≥ 7 can credit the courses approved by the concerned Department Curriculum Committee (DCC) and ratified by Board of Studies (BoS) in Engineering of Manipal University, in other institutions during 3^{rd} and 4^{th} year and during semester breaks.*

6.2 *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 *Students can earn external credits only from Indian/Foreign Universities/Institutions with which MU/MIT has a MoU for the above purpose.*

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

6.5 *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 DCC.*

6.6 *Maximum number of credits that can be transferred by a student shall be limited to 20.*

6.7 *Student has to get minimum passing grades/marks for such courses for which credits transfer is to be made.*

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

7. B. Tech. Honors

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

7.2 *Student needs to earn additional 12 credits of specified courses at level 500 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 publication from the work, as First author (8 credits)*

7.4 *Total Credit will be 170+20 = 190.*

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 minimum number of credits required to get promoted to 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 recommendation of an appropriate committee and approved by the vice chancellor.*

Department of Aeronautical and Automobile Engineering

The Department of Aeronautical and Automobile Engineering was established in 2008 with the objective of offering world-class education and cutting-edge research environment. The department strives for a healthy balance between teaching, research & development. Faculty of the department draws upon a long history of technical excellence, innovation and teaching performance, preparing graduates to contribute to the society with technically imaginative and commercially viable solutions. The mission is realised through its commitment to educational excellence, to the creation, development and application of the technologies critical to aerospace and automobile engineering. This program aims to promote aeronautical & automobile engineering by establishing close linkages between education, industry and research activities. The department has highly successful Centres of Excellence program to research best practices in unified approach to teaching and learning.

The students will have abundant opportunities for working on projects and internships across the globe, taking advantage of established relationships with aeronautical & automobile companies and research institutes. The students showcase their talent by developing several working models and presenting them in various prestigious national and international events. The students have won various awards at national and international level.

Programs offered

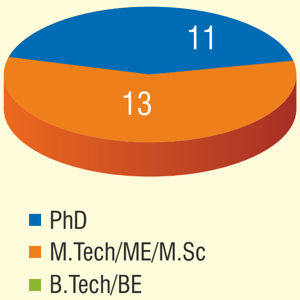
Under Graduate Programs
- B.Tech in Aeronautical Engineering (2008)
- B.Tech in Automobile Engineering (2008)

Post Graduate Program
- M.Tech in Automobile Engineering (2016)
- M.Tech Avionics (2019)

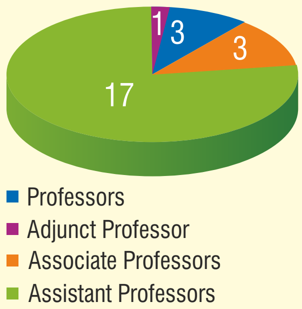
PhD

Faculty Strength

Qualification-wise



Cadre-wise



DEPARTMENT OF AERONAUTICAL & AUTOMOBILE ENGINEERING, MIT Manipal

M.Tech. AUTOMOBILE ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5155	Applied Numerical Methods	3	1	0	4	AAE 5271	Autotronics and Navigation	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	AAE 5272	Vehicle Dynamics	3	1	0	4
	AAE 5171	Automotive Engines and Subsystems	3	1	0	4	AAE ****	Elective I	3	1	0	4
	AAE 5172	Automotive Materials and Structures	3	1	0	4	AAE ****	Elective II	3	1	0	4
	AAE 5173	Combustion and Emission	3	1	0	4	AAE ****	Elective III	3	1	0	4
	AAE 5174	Vibration and Acoustics	3	1	0	4	*** ****	Open Elective	3	0	0	3
	AAE 5163	Materials Testing Lab	0	0	3	1	AAE 5263	Automotive Design and Simulation Lab	0	0	3	1
	AAE 5164	Vehicle Parts Modeling Lab	0	0	6	2	AAE 5264	Vibration and Acoustics Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**18**	**5**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	AAE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
AAE 5035	Advanced Powertrains	AAE 5041	Design for Manufacturing and Serviceability
AAE 5036	Automotive Control Systems	AAE 5042	Engineering Optimization and Reliability
AAE 5037	Battery and Fuel Cell Technology	AAE 5043	Finite Element Methods
AAE 5038	Computational Fluid Dynamics	AAE 5044	Manufacturing and Testing of Automotive Components
AAE 5039	Crashworthiness and Occupant Safety	AAE 5045	Tribology and Bearing Design
AAE 5040	Design and Analysis of Thermal Systems	AAE 5046	Vehicle Aerodynamics

OPEN ELECTIVES			
AAE 5054	Hybrid And Electrical Vehicles		

SEMESTER I

MAT 5155 APPLIED NUMERICAL METHODS [3 1 0 4]

Mathematical modeling and engineering problem solving: simple mathematical model, conservation laws and engineering. Approximations and round of errors: Accuracy and precision, error definitions, round off errors, truncation errors and Taylor's series. Roots of equations: Bracketing methods, open methods, roots of polynomials applied to engineering problems. Linear algebraic equations: LU decomposition and matrix inversion, special matrices and Gauss Seidel applied to engineering problems. Numerical Differentiation and Integration: Newton Cotes Integration formulas, integration of equations, numerical differentiation applied to engineering problems. Ordinary Differential Equations: RK methods, Boundary value and Eigen value problems. Partial Differential Equations: Finite difference method for elliptic and parabolic equation applied to engineering problems.

References:

1. Steven. C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, (2e) Tata McGraw Hill Edition, 2016.
2. Sastry S.S., Numerical Analysis for Engineers, (1e) Tata McGraw Hill Edition, 2002.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative & Mixed Methods Approaches, SAGE, 2004.
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

AAE 5171 AUTOMOTIVE ENGINES AND SUBSYSTEMS [3 1 0 4]

Basics of engine, operation, classification, types of engine, characteristics of engine, theory of carburetion and carbonator, electronics controlled carburetor system for Petrol engines, ignition system in SI engines, fuel supply in Diesel engine, injection system types, swirl and turbulence generation in combustion chamber, flame travel, combustion chamber design, engine testing and standard, methods to improve engine performance, performance map.

References:

1. Richard Stone, Introduction to Internal Combustion Engines, McMillan, London.
2. John B. Heyhood. Internal Combustion Engines Fundamentals, McGraw Hill.,2012.
3. Fayette Taylor & Edward S. Taylor, I. C. Engines, International text book com.
4. Heldt.P.M., High Speed Combustion Engines, Oxford IBH Publishing Co.,1965.
5. Obert.E.F., Internal Combustion Engine analysis and Practice, International Text Book Co, Scranton, Pennsylvania,1988.
6. Wiliam.H.Crouse., Automotive Engines, McGraw Hill Publishers, 1985.

AAE 5172 AUTOMOTIVE MATERIALS AND STRUCTURES [3 1 0 4]

Mechanical behavior of materials, structure of crystalline solids, plastic deformation, failure modes, creep mechanism, selection of materials for different components, manufacturing feasibility, modern materials and alloys, heat treatment process, advanced forming and joining , smart materials, composites, emerging trends of composites in automotive industry, mechanics of composite materials, body load, toughness characteristics and energy absorption characteristics of vehicle structure, optimization of vehicle structure.

References:

1. Raghavan V, Material science and engineering, Prantice Hall India, 2015.
2. Avner Sidney, Introduction to physical metallurgy, Mc Graw Hill International, 1995.
3. Johnson, W., and Mamalis, A.G., Crashworthiness of Vehicles, MEP, London, 1998.
4. Matthew Huang, Vehicle Crash Mechanics. CRC Press, 2002.
5. Powloski, J., Vehicle Body Engineering, Business Books Ltd., 1989.

AAE 5173 COMBUSTION AND EMISSION [3 1 0 4]

Introduction to combustion, principles and applications of combustion, characterization of fuels, laws of thermodynamics, fundamental laws of transport, basic reaction kinetics, global kinetics, regulatory test procedures, analysis of pollutants, pollution diagnosis, and instrumentation, NDIR analyzers, thermal conductivity and flame ionization detectors, EGR, catalytic converter, thermal reactors, fuel modifications

References:

1. Colin R. Ferguson, Allan T. Kirkpatrick, Internal Combustion Engines-Applied Thermosciences, John Wiley and Sons Inc., U.K., 2015.
2. Willard W. Pulkrabek, Engineering Fundamentals of Internal Combustion Engine, Pearson Education Inc., U.S.A, (1e) 2004.
3. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Pvt. Ltd., India, 2012.
4. J.B. Heywood, Internal Combustion Engine, Tata McGraw Hill Pvt. Ltd., India, 1989.
5. M.L. Mathur, R.P. Sharma, Internal Combustion Engine, Dhanpat Rai Publications, India, (2e) 1994.

AAE 5174 VIBRATION AND ACOUSTICS [3 1 0 4]

Vibration fundamentals, vibration measuring parameter and their values, single degree of freedom, torsional vibration, forced vibration, design of isolators, multidegree freedom system, finite element method, Eigen value problem, Cholesky factorization, concept of iteration, random vibration, random variable and processes, Gaussian random process, Fourier analysis, vibration measuring instruments, vibration transducers, vibration excitation techniques, fundamentals of signal analysis, data acquisition and processing, frequency domain analysis, dealing with random signals, fundamentals of acoustics, acoustic transducers and measurement, acoustic exciters, automotive vibration and noise.

References:

1. Sujatha C., Vibration and Acoustics, Tata McGraw Hill publication, 2010.
2. Matthew Harrison, Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Mathew Harrison Publication, 2004.
3. Malcolm J. Crocker, Handbook of Acoustics, John Wiley & sons Publication 1993.
4. Malcolm J. Crocker, Handbook of Noise and Vibration Control, John Wiley & sons Publication, 2007.
5. Singiresu S Rao, Mechanical Vibrations, Pearson education publication, 2004.

AAE 5163 MATERIALS TESTING LAB [0 0 3 1]

Deflection of simply supported beam, Verification of Maxwell's reciprocal theorem, Determination of young's modulus using strain gauge, Non-destructive testing using ultrasonic flaw detector, Non-destructive testing using C-Scan, Examination of flaw using magnetic flaw detector, Hardness test of given specimen, Determination of young's modulus of leaf spring, Determination of Modulus of rigidity of coil spring, Impact test, Torsion test, Tension test, Fatigue test, Flexural test.

References:

1. Egor P. Popov, Engineering Mechanics of Solids 2e, Prentice Hall 1998.
2. Beer, F.P., Johnston, E.S. & DeWolf, J.T., Mechanics of Materials 3e, Tata McGraw-Hill, 2004.
3. Gere, J.M., Mechanics of Materials 5e, Brooks/Cole, 2001.
4. Srinath L.S. Advanced Mechanics of Solids 3e, Tata McGraw-Hill, 2009
5. Bhavikatti S.S., Mechanics of Solids New Age International 2010.

AAE 5164 VEHICLE PARTS MODELING LAB [0 0 6 2]

Basics of CATIA and Creo PRO-E, two dimensional modeling of modeling techniques, three dimensional modeling techniques, Modeling of automotive systems and its subsystems; engine, piston, crank shaft, disc, drum brake, tire, hub, surfacing, modeling of car using views. Assembly of components.

References:

1. Michael Michaud, CATIA Core Tools: computer aided three dimensional interactive applications, McGraw Hill Professional Publication, 2012.
2. Prof Sham Tickoo, CATIA V5R17 for engineers & Designers, Dreamtech Press Publication, 2008.
3. Nadar G Zamani, Jnonathan M Weaver, Catia V5 tutorials mechanisms, Design & Animation relase 21, SDC Publication, 2012.
4. Sean Harris, Adithya Chopra, Creo Elements Pro E - Comprehensive Guide to CAD/CAM, Createspace Independent Pub, 2014.
5. Kuang-Hua Chang, Mechanism Design with Creo Elements/Pro 5.0: (Pro/ENGINEER Wildfire 5.0), SDC Publication, 2011.

SEMESTER II

AAE 5271 AUTOTRONICS AND NAVIGATION [3 1 0 4]

Microprocessor and micro computer application, engine management systems, chassis management system, sensor and actuators, auxiliary systems, new developments, automotive navigation system, application of navigation system, traffic control, mobile mapping, pedestrian navigation, GPS, navigation massage generation, inertial navigation system(INS), mobile land vehicle INS, strap-down INS, automatic navigation system with multiple sensors, geographical information system (GIS), GIS data base and laser scanning, location and navigation systems based on LEDs.

References:

1. William B Ribbens, Understanding Automotive Electronics, (6e), Newnes, 2003.
2. Tom Denton, Automobile Electrical and Electronics systems, (4e), Routledge Taylor & Francis group, 2012.
3. Zhao, Y., Vehicle Location and Navigation Systems, Artech House, Inc. Boston, London, 1997.
4. I.Skog, Development of a low cost GPS aided INS for vehicles, Technical Report, Dept. of Signals, Sensors and Systems, Royal Institute of Technology, Sweden, 2005.
5. Richardson, B., Green, P. and Ann Arbor, Trends in North American Intelligent Transportation Systems: A Year 2000 Appraisal (Technical Report UMTRI-2000-9), MI: The University of Michigan transportation Research Institute, 2000.
6. Gilliéron P Y, A mobile mapping system for automating road data capture in real time, Optical 3D, Vienna, Oct 2001.

AAE 5272 VEHICLE DYNAMICS [3 1 0 4]

Vehicle dynamics and control, basics of vehicle dynamics, kinematics equation of motion, multi body dynamics, A car model; virtual four wheel vehicle modal, force and torque, tire mechanics, tire force and torque, tire characteristics, contact geometry, tire cornering characteristics, Fiala's theory, mathematical model for braking and cornering, fundamentals of vehicle dynamics and characteristics, nonlinear effect of tire, vehicle motion disturbance, traction control system, ABS, hydraulic unit for ABS and EPS, active steering system.

References:

1. Georg Rill, Road Vehicle Dynamics; Fundamentals and Modeling, CRC press publication, 2012.
2. Martin Meywerk, Vehicle Dynamics, Wiley publication, 2015.
3. Masato Abe, Vehicle Handling Dynamics; Theory and Application, Butterworth-Heinemann publication, 2015.
4. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, Technology & Engineering publication, 1992.
5. Pacejka H. B., Tire and Vehicle Dynamics, Butterworth-Heinemann publication, 2012.

AAE 5263 AUTOMOTIVE DESIGN AND SIMULATION LAB [0 0 3 1]

Basic introduction to ANSYS and MATLAB, deformation of different chassis structure, engine block, disc brake, Thermal analysis; engine block, piston, Modal analysis; connecting road Math Lab: Design of dump truck, analysis of automobile shock absorber. Engine model simulation, Vehicle dynamics, rigid body dynamics, and cruise control simulation.

References:

1. Choudary R B, Introduction to ANSYS10.0, IK International, 2009.
2. Esam M A, Finite element simulation using ANSYS, Taylor & Francis Publication, 2010.
3. MATLAB 6 for Engineers: Hands-on Tutorial, Joe King, Library of Congress publication, 2001.
4. Rao V Dukkipati, MATLAB for Mechanical Engineers, New age Science Publication, 2009.
5. Misza Kalechman, Practical MATLAB basics for engineers, CRC Press Publication, 2010.

AAE 5264 VIBRATION AND ACOUSTICS LAB [0 0 3 1]

Viscous damping, forced vibration setup, whirling of shaft, condition monitoring unit, modal analysis, balancing of disc.

References:

1. Sujatha C., Vibration and Acoustics, Tata McGraw Hill publication, 2010.
2. Matthew Harrison, Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Mathew Harrison Publication, 2004.
3. Malcolm J. Crocker, Handbook of Acoustics, John Wiley & sons Publication, 1993.
4. Malcolm J. Crocker, Handbook of Noise and Vibration Control, John Wiley & sons Publication, 2007.
5. Singiresu S Rao, Mechanical Vibrations, Pearson education publication, 2004.

SEMESTER III and IV

AAE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

AAE 5035 ADVANCED POWERTRAINS [3 1 0 4]

Requirement of transmission system, Layouts of transmission systems with different engine locations, automotive clutches, principle, construction, design aspects of friction clutches, Determination of gear ratios for vehicles, Different types of gearboxes, Design of propeller shafts, Hydrodynamic Drive, Automatic Transmission, Electronically controlled automatic transmission systems, Hydrostatic Drive systems, Various types of hydrostatic drive systems, Principles of hydrostatic drive system, Construction and working of typical Janny hydrostatic drive, electric drive, Principles of early and modified Ward Leonard Control system, Toyota ECT-I automatic transmission with intelligent electronic control system.

References:

1. Lukin P, Gasparyarts G, Rodionov V, Automotive Chassis – Design and Calculation, MIR Publishing, Moskow.
2. Heldt P. M, Automotive Chassis, Chilton Co.
3. Steed W, Mechanics for Road Vehicles, Illiffe Books Ltd., London.
4. Heinz Heisler, Advanced Vehicle Technology, (2e), Butterworth – Heinemann, New York, 2002.
5. Giri N. K, Automobile Mechanics, Seventh reprint, Khanna Publishers, Delhi, 2005.
6. Heldt P. M, Torque Converters, Chilton Book Co., 1992.
7. Garret T. K, Newton K.Steeds W. , The Motor Vehicle, (13e), Butterworth Heinemann, India, 2004.

AAE 5036 AUTOMOTIVE CONTROL SYSTEMS [3 1 0 4]

Automatic control system, feedback control systems, stability, performance and characteristic analysis, vehicle body dynamics, dynamics model and simulation, engine control system, engine management system, engine control module, control system development tools, driveline control, vehicle system control, ABS control, road and driver model, stability control, cruise control system, intelligent cruise control, adaptive and autonomous cruise control.

References:

1. Richard C. Dorf and Robert H. Bishop, Modern Control System, (8e), PEARSON Education, 1998.
2. Uwe Kiencke and Lars Nielsen, Automotive Control Systems for Engine, Driveline and Vehicle, (2e), Springer, 2005.
3. Allan W. M. Bonnick, Automotive Computer Controlled Systems, Diagnostic tools and techniques, 1st published, Butterworth-Heinemann OXFORD Auckland Boston Johannesburg Melbourne New Delhi, 2001.
4. Dave Walker, Engine Management, Haynes High performance series, 2008.
5. Newton K and Steeds W, Motor Vehicle, Butter Worths & Co., Publishers Ltd, 1997.

AAE 5037 BATTERY AND FUEL CELL TECHNOLOGY [3 1 0 4]

Introduction and Description of Automotive Battery System Architecture, Classification and Application of Safety Measures for Automotive Battery Systems, Application of Measures at Battery System Units, Specific Hazards of Electric Vehicles, Applicable Design Approach for Batteries, Batteries in Crash Tests and Crash Simulation, Finite Elements Model of the Battery, Thermal Runaway Experiment and modelling. Thermal Behaviour, Electrical Behaviour, Distributed-Micro-Structure Modelling**,** Mobility Demands and Primary Energy Resources, Basic Concepts of Electrochemistry, Proton Exchange Membrane Fuel Cells, Sensitivity of Durability of PEM Fuel Cells, Design of Hydrogen Fuel Cell Hydrogen Fuel Cell Systems. Integrated Fuel Cell System.

References:

1. Pasquale Corbo, Fortunato Migliardini, Ottorino Veneri, Hydrogen Fuel Cells for Road Vehicles, Springer London Dordrecht Heidelberg New York, ISBN 978-0-85729-135-6, 2011.
2. Michael H. Westbrook, The Electric Car Development and future of battery, hybrid and fuel-cell cars, Co-published by The Institution of Engineering and Technology, London, United Kingdom, and Society of Automotive Engineers, Warrendale, PA 15096-0001, USA, ISBN (13 digit) 978-0-85296-013-4, 2007.
3. Alexander Thaler, Daniel Watzenig, Automotive Battery Technology, Springer Cham Heidelberg New York Dordrecht London, ISBN 978-3-319-02522-3, 2009.
4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Press, ISBN-I O: 1420053981, ISBN-13; 978-1420053982, 2009.

5. Amir Khajepourj M. Saber Fallahi Avesta Goodarzi, Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach, Wiley, ISBN: 978-1-118-86340-4, 2010.

AAE 5038 COMPUTATIONAL FLUID DYNAMICS [3 1 0 4]

Governing equation of fluid mechanics, continuity equation, momentum and energy equation, Initial and boundary conditions, Equilibrium and Marching behavior, format of differential equation, explicit Taylor series expansion, steady state conduction heat transfer, 2D heat conduction, unsteady conduction heat transfer, implicit and Crank Nicholson method, space and time marching problems, comtrol volume techniques, diffusion convection flow, SIMPLE algorithms, boundry conditions in CFD, introduction to turbulence.

References:

1. John D Anderson Jr., Computational Fluid Dynamics- The Basics with Applications, International Edition. McGraw Hill. New York, 1995.
2. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow- Hemisphere, McGraw Hill. New York, 1980.
3. H.K. Versteeg and W. Malalasekera,An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Longman Scientific & Technical England, 1995.
4. K.Muralidhar and T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, NewDelhi, 2003.
5. Anderson D.A, Tannehill J.C, and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, Taylor and Francis Group. New York, 1997.
6. T.J. Chung., Computational Fluid Dynamics, Cambridge University Press, South Asia Edition, 2003.

AAE 5039 CRASHWORTHINESS AND OCCUPANT SAFETY [3 1 0 4]

Introduction to automotive structure, crashworthiness, occupant safety, design of vehicle structure for crash energy management, design practice for crash, crash/crash design techniques, stiff cage structure concept, vehicle front structure design, vehicle frontal collision, finite element analytical techniques and application of structure design, explicit formulation, fundamental principle for vehicle/ occupant system analysis, barrier collision, laws of motion, energy and work, restrain performance and design, human body modeling, dynamic joint modeling, dummy modeling, modeling of real human body, injury biomechanics, head injury mechanism, thoracic injury mechanism, chest injury, abdominal injury, lower extremity injury mechanism.

References:

1. Paul Du Bois Clifford C. Chou Bahig B. Fileta Tawfik B. Khalil Albert I. King Hikmat F. Mahmood Harold J. Mertz Jac Wismans, Vehicle Crashworthiness and Occupant Protection, Automotive Applications Committee American Iron and Steel Institute Southfield, Michigan, 2004.
2. Narayan Yoganandan, Alan M. Nahum, John W. Melvin, Accidental Injury: Biomechanics and Prevention, The Medical College of Wisconsin Inc, 2015.
3. CAE Methods for Vehicle Crashworthiness and Occupant Safety, and Safety-critical Systems, SAE special publication: Society of Automotive Engineers, 2004.
4. Jorge A.C. Ambrosio, Crashworthiness: Energy Management and Occupant Protection, Springer-Verlag Wein publication Newyork, 2001.

AAE 5040 DESIGN AND ANALYSIS OF THERMAL SYSTEMS [3 1 0 4]

Introduction, basics of themodynamics, modes of heat transfer, engineering design, modeling of thermal systems, mathematical and physical modeling, basic heat exchanger design, materials for thermal application, super conductive materials, nanomaterials, optimization in design, programing, economic factors in design.

References:

1. Adrian Bejan, George Tsatsaronis, Michael Moran, Thermal Design and Optimization, John Wiley & Sons, 1996.
2. Robert F. Boehm, Developments in Design of Thermal Systems, Cambridge University Press, 1997.
3. W.F. Stoecker, Design of thermal systems, Tata Mcgraw-hill, 2011.
4. R.F. Boehm, Design analysis of thermal systems, Wiley, 1987.
5. Yogesh Jaluria, Design and Optimization of thermal systems, CRC Press, Taylor & Francis, 2007.

AAE 5041 DESIGN FOR MANUFACTURING AND SERVICEABILITY [3 1 0 4]

Manufacturing, design for manufacturing, mechanical and physical properties materials, tolerance analysis and allocation, Taguchi's approach, principle of selective assembly, selection of materials for manufacturing process, process selection, DFM guidelines, design for casting, powder metallurgy, sheet metal forming, design for assembly, assembly process design for welding, brazing, bonding, joining, design for serviceability, cost relationship, standardization, mistake proof assembly, improve of DFS.

References:

1. Design for Manufacturing and Assembly: Concepts, Architectures and Implementations, O. Molloy, Steven Tilley, E. A. Warman; Springer Books, 1998.
2. Handbook for Product design and manufacturing, James G Bralla, McGraw Hill, 1986.
3. Tolerance Design-A handbook for developing optimal specifications, C.M. Creveling, Addison-Wesley, 1997.
4. Design for Manufacturing- A structured approach, Volume1, C. Poli; Buttworth-Heinneman, Elsevier publications, 2001.
5. Product Design for Manufacturing and Assembly, Geoffery Boothroyd, CRC Press, (3 e) 2010.

AAE 5042 ENGINEERING OPTIMIZATION AND RELIABILITY [3 1 0 4]

Single variable optimization algorithms, local and global optima, bracketing methods, Fibonacci search method, gradient based method, Newton Raphson method, multivariable unconstrained optimization, direct search method, nonlinear optimization simplex search, Hooks & Jeeves pattern search, multivariable constrained optimization, Lagrange multiplier method, Kuhn-Tucker condition, cutting plane method, integral programing and geometric programming, genetic algorithm, ant colony optimization, particle swarm optimization, Tabu search.

References:

1) Rao S. S., Engineering Optimisation (3e) John Wiley & Sons 2009.
2) Kalyanmoi Deb, Optimisation for engineering Design Prentice Hall India, 1995.
3) Chander Mohan & Kusum Deep, Optimisation Techniques New Age Science Ltd. 2009.
4) Onwubolu G.C., Babu B.V., New Optimisation Techniques in Engineering, Springer 2004.
5) Kalyanmoi Deb, Multi-objective optimization using evolutionary algorithms, John Wiley and sons, 2001.

AAE 5043 FINITE ELEMENT METHODS [3 1 0 4]

Introduction to matrix notations, role of computer, General steps in Finite element methods, Application of Finite element method, Advantages of Finite element methods. Definition of stiffness matrix, Derivation of stiffness matrix for spring elements, Transformation of vectors in 2D, Global stiffness matrix, computation of stresses in bar in x-y plane, Use of symmetric structure, beam stiffness, assemblage of beam stiffness matrices, distributed loading, beam element with nodal hinge, potential energy method, Galerkin method for deriving he beam element equation, Basic concept of plane stress and plane strain, derivation of the constant Strain triangle element stiffness matrix and equations, Derivation of the Liner Strain triangular element stiffness matrix and examples.

References:

1. Zienkiewicz O C and Taylor R L., Finite Element Method for Solid and Structural Mechanics,Elsevier, 2013.
2. RaoSingiresu S., Finite Element Method in Engineering, Butterworth and Heinmann, 2011.
3. Huebner Kenneth H, Finite element method for Engineers, John Wiley and Sons., 2008.
4. Reddy JN., Introduction to the Finite Element Method, McGraw Hill., 2006.
5. Logan D L., First Course in the Finite Element Method, Thomson., 2011.

AAE 5044 MANUFACTURING AND TESTING OF AUTOMOTIVE COMPONENTS [3 1 0 4]

Basic of vehicles, manufacturing of engine parts; piston, piston ring, crank shaft, automotive silencer, automotive chain, cylinder liner, mounting pad, manufacture of valve and valve seat, processes and methodology, alternative process of manufacture, manufacture of cylinder block, presumption, technical aspects, quality control, automotive body manufacture process, manufacture of disc and brake drum, manufacture of leaf spring, measurement and testing, failure preventions.

References:

1. B.P. Bhardwa, The Complete Book on Production of Automobile Components & Allied Products, asia pacific business press Inc, NIIR Project Consultancy Services, 2014.
2. K. J. Marsh, Full-Scale Fatigue Testing of Components and Structures, butterworth & co ltd, 1988.
3. V Ganesan, Internal combustion engines, Tata McGraw Hill Eduaction Private LTD, 2012.
4. A. J. Martyr and M A Plint,Engine Testing: Theory and Practice, Butterworth & Heinemann Publication, 2007.

AAE 5045 TRIBOLOGY AND BEARING DESIGN [3 1 0 4]

Introduction to tribology, laws of friction, theories of friction, wear, lubrication, viscosity, Newtonian fluid, absolute and kinematic viscosity, effect of temperature and pressure on viscosity, viscosity index, introduction to selection and classification of bearings, hydrodynamics and hydrostatic bearing, rolling element bearing, design of sliding contact bearing, journal bearing, journal bearing design and procedure, minimum film thickness, air bearings, design of hydrostatic bearings, selection and design of rolling bearing, contact stresses in bearing, fatigue life calculation, introduction to rotor dynamics.

References:

1. Michael M. Khonsari, E. Richard Booser, Applied Tribology: Bearing Design and Lubrication, Wiley publication, 2008.
2. Rowe W. B, Hydrostatic, Aerostatic, and Hybrid Bearing Design, Butterworth-Heinemann publication, 2012.
3. Majumdar B.C, Introduction to Tribology of Bearings, S. Chand & Company publication, 2008.
4. Bharat Bhushan, Introduction to Tribology, Wiley Publication, 2013.
5. Tadeusz Stolarsk, Tribology in Machine Design, Butterworth-Heinemann publication, 2000.

AAE 5046 VEHICLE AERODYNAMICS [3 1 0 4]

Introduction, Historical development, Fundamentals of fluid mechanics, Properties of incompressible fluid, basic equations of incompressible flow, Friction drag and pressure drag, Aerodynamic drag of passenger cars, Aerodynamics of commercial vehicles, tractive effort and fuel consumption, reducing aerodynamic drag in trucks, Aerodynamics of high performance vehicles, Aerodynamic features of race cars, vehicle dynamics under side wind, influence of vehicle shape on aerodynamic forces and moments, Experimental Procedure and Facilities, Types of wind tunnels, Instrumentation for wind tunnels: pressure measurement, velocity measurement, force and moment measurement devices, Flow visualization.

References:

1. Hucho W.H., Aerodynamic of Road vehicles, Butterworths Co. Ltd, 1997.
2. Wolf-Heinrich Hucho, Aerodynamics of Road Vehicles: From Fluid Mechanics to Vehicle Engineering, 1990.
3. Pope. A., Wind Tunnel Testing, John Wiley & Sons, (2e), New York, 1974
4. Handbook on vehicle body design, SAE Publications,1993.
5. Rose McCallen, Fred Browand, The Aerodynamics of Heavy Vehicles: Trucks, Buses, and Trains, Volume 1, 2004.

OPEN ELECTIVES

AAE 5054 HYBRID & ELECTRICAL VEHICLES [3 0 0 3]

Introduction to alternative vehicles, developments, environmental impact, architecture of hybrid and electrical vehicles, basics of electric and hybrid vehicles, hybrid power trains, series and parallel hybrid systems, electrical propulsion systems, configuration of motors, introduction to energy storage systems, fuel cell, super capacitor, powertrain systems in hybrid vehicles, two mode hybrid transmission, torque coupling mechanism, energy management systems, diagnostics method.

References:

1. Chris Mi, Abdul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Prespectives, Wiley Publications, 2011.
2. James Larminie Electric Vehicle Technology Explained, Wiley Publications, 2003.
3. Mehrda Ehsani, Yimi Gao Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

DEPARTMENT OF AERONAUTICAL & AUTOMOBILE ENGINEERING, MIT Manipal.

M.Tech. AVIONICS

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5161	Computational Methods	3	1	0	4	AAE 5251	Airborne Platform -System Design Approach	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	AAE 5252	Navigation, Guidance and Control	3	1	0	4
	AAE 5151	Avionics System Engineering	3	1	0	4	AAE ****	Elective I	3	1	0	4
	AAE 5152	Digital Avionics and EMI/EMC	3	1	0	4	AAE ****	Elective II	3	1	0	4
	AAE 5153	Flight Instrumentation and Data Acquisition	3	1	0	4	AAE ****	Elective III	3	1	0	4
	AAE 5154	Mechanics of Flight	3	1	0	4	*** ****	Open Elective	3	0	0	3
	AAE 5161	Automatic Flight Control Systems Lab	0	0	6	2	AAE 5261	Embedded System-Software Safety and Security Lab	0	0	3	1
	AAE 5162	Avionics System Engineering Lab	0	0	3	1	AAE 5262	Wireless Communication Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**18**	**5**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	AAE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES

AAE 5001	3D Mapping/Photogrammetry Mapping Software Analysis	AAE 5013	Digital Fly-By Wire Control	AAE 5025	Practical Cryptography in C/C++
AAE 5002	Adaptive Control	AAE 5014	Digital Imaging Sensors	AAE 5026	Programming Languages for Image Processing and Computer Vision Algorithm
AAE 5003	Airborne Thermal Imaging System	AAE 5015	Digital Signal Processing	AAE 5027	Radar
AAE 5004	Aircraft Computer Systems and Networks	AAE 5016	Electro Optic Systems	AAE 5028	Real Time Data Telemetry Development and Application
AAE 5005	Aircraft Databus	AAE 5017	Embedded Systems: Software Safety and Security of Embedded System	AAE 5029	RF and Microwaves Engineering
AAE 5006	Aircraft Electrical System	AAE 5018	Ground Airport Navigation and Communication System	AAE 5030	Satellite Communication System
AAE 5007	Antenna Designing, Simulation and Placement for Aerospace	AAE 5019	Humanoid Robots	AAE 5031	Smart Sensors Development and Application
AAE 5008	Artificial Intelligence and Machine Learning	AAE 5020	Image Processing and Computer Vision	AAE 5032	Soft Computing Systems
AAE 5009	Cryptology, Cryptography and Cryptoanalysis	AAE 5021	Kalman Filter and Application	AAE 5033	System Modeling and Simulation
AAE 5010	Decision Support System in Aerospace Application	AAE 5022	MEMS/MMIC In Aerospace Application	AAE 5034	Virtual Reality and 3D Imaging for Military Simulation
AAE 5011	Digital and Analog Communication	AAE 5023	Missile Guidance		
AAE 5012	Digital Control System	AAE 5024	Optimal Control		

OPEN ELECTIVES

AAE 5051	Antenna Design, Simulation and Placement for Aerospace	AAE 5052	Unmanned Aircraft System

SEMESTER I

MAT 5161: COMPUTATIONAL METHODS [3 1 0 4]

Mathematical Modeling with ordinary/partial/higher order differential equations: Models in arms race, compartment models, heat flow problems and vibration of strings. Modeling through graphs. Solution of linear and nonlinear system of equations: Direct methods, Newton Raphson method (system of non-linear equations), Birgevieta method, Bairstow's methods. Numerical Solution of Ordinary Differential Equations. Multi step methods: Boundary Value Problems: Integral Transforms: The Fourier transform pair. Laplace transforms of elementary functions – inverse Laplace transforms

References:

1. Atkinson K.E., An Introduction to Numerical Analysis (2e), John Wiley and Sons 1989.
2. Smith G.D., Numerical Solution of Partial Differential Equations, (3e) Oxford University Press, 2004.
3. Jain, Iyengar and Jain, Numerical methods for Scientific and Engineering Computations, New Age Publishers.
4. Kapoor J.N., Mathematical Modeling, Wiley Eastern, 1988.
5. Aris R., Mathematical Modeling Techniques, Pitmanm 1978.
6. Kreyszig, E., Advanced Engineering Mathematics, (10e), John Wiley 2011.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of research methodology: basic concepts: types of research, significance of research, research framework case study method, experimental method, sources of data, data collection using questionnaire, interviewing, and experimentation. Research formulation: components, selection and formulation of a research problem, objectives of formulation, and criteria of a good research problem. Research hypothesis: criterion for hypothesis construction, nature of hypothesis, need for having a working hypothesis, characteristics and types of hypothesis, procedure for hypothesis testing; sampling methods: introduction to various sampling methods and their applications. Data analysis: sources of data, collection of data, measurement and scaling technique, and different techniques of data analysis. Thesis writing and journal publication: writing thesis, writing journal and conference papers, IEEE and Harvard styles of referencing, effective presentation, copyrights, and avoiding plagiarism.

References:

1. Dr. Ranjit Kumar, Research Methodology; A Step-by-Step Guide for Beginners, SAGE. 2005.
2. Geoffrey R. Marczyk, David De Matteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods approaches, SAGE. 2004.
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2Vols-Set), Vedam Books., 2006.
5. C. R. Kothari, Research Methodology; Methods & Techniques, new age international publishers, New Delhi., 2008.

AAE 5151 AVIONICS SYSTEM ENGINEERING [3 1 0 4]

Introduction of Systems Engineering, avionics system engineering, system project management and software system engineering. Avionics life cycle cost, schedule and risk management, system engineering principle to avionics system, Existing avionics systems and their functions, new avionics subsystem and their base, project management of avionics engineering, software design, development and integration to system., Avionics Systems Essentials, Design areas of concern to system engineers, FARs, and certification requirements, identify design evaluation criteria and assign weighting values to the evaluation criteria, System requirements System engineering concepts, functional design, trade studies for the best system design.

References:

1. Cary R. Spitzer, Digital Avionics Handbook: -Avionics Development and Implementation, 2nd Edition, CRC Press, Taylor & Francis Group, 2007.
2. Blanchard, Benjamin S., and Fabrycky, Wolter J., Englewood Cliffs, N.J, System Engineering and Analysis, Prentice-Hall, 1990.
3. Defense Systems Management College, Systems Engineering Management Guide, U.S. Government Printing Office, December 1989.
4. United Airlines Staff. Avionics Fundamentals, IAP, Incorporated, 1987.
5. Kendal B. Manual of Avionics Blackwell Scientific Publications, Melbourne, 1993.
6. Pallett E.H.J. Aircraft Instruments, 3rd Edition Longman, London, 2011.

AAE 5152 DIGITAL AVIONICS AND EMI/EMC [3 1 0 4]

Evolution of Avionics: digital avionics overview-airframe manufacture's point of view and ATA Safety and Certification-Communication, Navigation, Global positioning system, Fault Tolerant Avionics, Electromagnetic Environment, Vehicle health management, system safety and development, RTCA DO-160, DO-178B/C, DO-254, Avionics functions: Human factors engineering and flight deck design, Display devices, Electrical systems, Air traffic control demonstration aspects, Flight critical digital control systems, Fault tolerant systems, Avionics Tools, Technique and Methods: Electronic Hardware reliability, Integrated Modular Avionics Design and certification, Avionics application software standard interface, Packaging, EMI/EMC: EMI/EMC requirements BIT and CFDS, Cash flow analysis, Software costs, Establishing spares level, EMC Testing on Airborne Equipment, Aircraft Generated Electromagnetic Interference on Future Electronic Systems, Electromagnetic Interference to Flight Navigation and Communication Systems

References:

1. Cary R. Spitzer, Uma Ferrell and Thomas Ferrell and Associates Consulting, Inc. Thomas Ferrell, Digital Avionics Handbook, Third Edition, CRC Press Taylor & Francis Group, LLC, 2015.
2. Dr. Reinaldo J. Perez, Handbook of Aerospace Electromagnetic Compatibility, IEEE Press, Wiley, 2018.
3. Authors of Conference et al, Digital Avionics System Conference, Boston, MA, U.S.A. https://doi.org/10.2514/MDAS75, 02 April 1975 - 04 April 1975.
4. Cary R. Spitzer, Digital Avionics Handbook: -Avionics Development and Implementation, 2nd Edition, CRC Press, Taylor & Francis Group, 2007.
5. Spitzer, C.R., Digital Avionics Systems, Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987
6. Chris Kendall et al, Aircraft Generated Electromagnetic Interference on Future Electronic Systems, DOT/FAA/CT-83/49, Federal Aviation Administration, 1983.

AAE 5153 FLIGHT INSTRUMENTATION AND DATA ACQUISITION [3 1 0 4]

Basics of Aircraft, Aircraft instruments Types and Cockpit Layout, Air data Instruments, flight instruments, Flight control systems-AFCS, Electrical systems -Aircraft power generation and power distribution, Flight Management Systems FMS, FAN, Black Boxes Cockpit Voice Recorder and Flight Data Recorder, etc. Environmental condition systems, Aircraft Safety and warning Systems, Emergency systems - Aircraft Communication Navigation Systems, Technology-databuses and avionics protocols, microelectronics devices, Introduction to Data Acquisition and Signal Conditioning, Signals, Sensors, and Signal, Military Data Acquisition Systems and Instruments Datasheets

References:

1. Ian Moir, Allan Seabridge, Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration, 3rd Edition, Aerospace Series, Wiley, 2011.
2. Measurement and Computing, Data Acquisition Handbook, Measurement and Computing Corporation, 2012.
3. Thomas K. Eismin, Aircraft Electricity and Electronics, (6e) McGraw Hill Education(India) Private Limited.
4. S. Nagabhushana and L.K. Sudha, Aircraft Instrumentation and Systems, Publisher: I K International Publishing House, 2010.
5. Henderson Max F. Aircraft Instruments and Avionics for A & P Technicians, Casper Wyo 1993.
6. S. Nagabhushana and N. Prabhu, Principles of Modern Avionics, I K International Publishing House, 2018.

AAE 5154 MECHANICS OF FLIGHTS [3 1 0 4]

Introduction to Air Vehicle Stability and Flight Controls —including a brief history of aircraft development with an emphasis on stability and flight control, Review of Basic Aerodynamics, Propulsion and Flight Vehicle Performance, Aircraft Equations of Motion, Aircraft Static Stability, Aircraft Dynamic Stability, Structural modeling and aircraft flexibility, Classical Feedback Control, Orbital Mechanics, Kinematics of spacecraft, rigid body dynamics, Trajectory analysis and design.

References:

1. Thomas R. Yechout, Introduction to Aircraft Flight Mechanics, AIAA Education Series, Copyright 2003.
2. Bernard Etkin, Dynamics of Atmospheric Flight, John Wiley & Sons, Inc, 2005.
3. Robert C. Nelson, Flight Stability and Automatic Control, (2e), The McGraw-Hill Companies, Inc, 1997.
4. John H. Blakelock, Automatic Control of Aircraft and Missiles, (3e), John Wiley & Sons, Inc, 1991.
5. Kermondes, A. C., Mechanics of Flight, Prentice Hall, 2012.
6. Anderson Jr., J. D., Introduction to Flight, McGraw-Hill, 2015.

AAE 5161 AUTOMATIC FLIGHT CONTROL SYSTEMS LAB [0 0 6 2]

Aircraft dynamics simulation, Flight trajectory optimization, navigation, guidance and control, Design of AFCS (Automatic Flight Control System), Fly-by-Wire flight control, Adaptive control-AiStar, F-16, TEJAS etc, Practical issues in design and implementation.

Flying and Handling qualities, Autopilot, Actuation system, Autonomous UAV Design, instrumentation and flight testing, mathematical modelling and simulation, Flight test data analysis, swarm and cooperative etc.

Object Tracking-Ergonomics and Robot, motion capture, Vision based aerial manipulation, control and navigation, Constrained motion planning, Fault tolerant flight control, Sensor fusion, Formation flight control, Human/Machine interface, IMU Research-Raw data analysis of various motions indoor or outdoor of laboratory, motion gesture, Robot manipulator etc. Thrust vectoring control, Engine control.

References:

1. Ching-Fang Lin, Modern Navigation, Guidance, And Control Processing, Volume II, Prentice Hall; 1997.
2. Eugene Lavretsky, Robust and Adaptive Control: With Aerospace Applications, Springer, 2013.
3. Darrol Stinton, Flying Qualities and Flight Testing of the Airplane, AIAA Education, American Institute of Aeronautics and Astronautics, 1998.
4. Miomir Vukobratovic and Dragan Stokic, Applied Control of Manipulation Robots: Analysis, Synthesis and Exercises, Springer, 1989.
5. Doru Talaba & Angelos Amditis, Product Engineering: Tools and Methods Based on Virtual Reality, Intelligent Systems, Control and Automation: Science and Engg. Series, Springer, 2008.
6. Brian L. Stevens, Frank L. Lewis & Eric N. Johnson, Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, (3e) Wiley-Blackwell, 2015.

AAE 5162 AVIONICS SYSTEM ENGINEERING LAB [0 0 3 1]

Software simulation-System engineering, Flight simulator, software in loop simulation (SILS), Hardware in loop simulation (HILS), Processor in Loop simulation, Formation flying, Vision based navigation, Flight test data analysis of drones/aircraft, Avionics Test Bench, Electrical Ground support Equipments, Active Noise control for pilot helmet, Software Define Radio [SDR], HMI, Network Analyzer, Communication and Navigation systems, Aircraft Display, Visual systems, DME, IFF, VOR, ILS, ADF, RADAR, Sensors etc, Design and Development of microelectronics system from requirement to validation/documentation, Embedded system development-Keil software application, microcontroller /microprocessor-ARM, DO178B/C certification for software and hardware development, RF Analysis, High Bandwidth Signal analysis, Digital protocol analysis, network and databus protocols, Signal analysis, GCS Design and integration, Power Meter, Digital Multimeter, RF Analyzer, Signal Generator, Spectrum Analyzer etc.

References:

1. David Allerton, Principles of Flight Simulation, Aerospace Series, John Wiley & Sons, 2009.
2. Cary R. Spitzer, Digital Avionics Handbook: Avionics Development and Implementation, (2e) CRC Press, Taylor & Francis Group, 2007.
3. Jonathan W Valvano, Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, (2e), Createspace Independent Publishing Platform; 2012.
4. S. Nagabhushana and N. Prabhu, Principles of Modern Avionics Paperback, I K International Publishing House, 2018.
5. Len Buckwalter, Avionics Training: Systems, Installation, and Troubleshooting, Avionics Communications Inc., 2005

SEMESTER II

AAE 5251 AIRBORNE PLATFORM-SYSTEM DESIGN APPROACH [3 1 0 4]

Introduction to Unmanned Aircraft Systems (UAS) and Applications of UAS, Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects, Aspects of Airframe Design, Design for Stealth -different signature, Payload Types, Communications, Control and Stability- HTOL, Helicopters, Convertible Rotor Aircraft, Payload Control, Sensors and Autonomy, Navigation, Launch and Recovery, Control Stations- Control Station Composition, System Architecture, Mini-UAV 'Laptop' Ground Control Station, GCS for UAVs, types. Support Equipment, Transportation, Design for Reliability, EMC/EMI of UAS. Introduction to System Development and Certification, System Development, Certification, Establishing Reliability, UAV System testing, system -in flight testing, sites study, Operational Trials and Full Certification, UAV System Deployment, Defence Application-Navy Role, Army Role, Airforce Role, Civilian, Paramilitary and Commercial Roles, Prospects and Challenges and Evolution.

References:

1. Reg Austin, Unmanned Aircraft Systems UAVs Design, Development and Deployment, A John Wiley and Sons, Ltd., 2010.
2. Jay Gundlach, Designing Unmanned Aircraft Systems: A Comprehensive Approach (2e), AIAA Education Series, 2014.
3. Jay Gundlach, Civil and Commercial Unmanned Aircraft Systems, AIAA Education Series, 2016.
4. Dr David C. Ison, Small Unmanned Aircraft Systems Guide: Exploring Designs, Operations, Regulations, and Economics, Aviation Supplies & Academics Inc, 2017.
5. Douglas M. Marshall et al., Introduction to Unmanned Aircraft Systems, Second edition Taylor & Francis, 2016.
6. F.B. da Silva S.D. Scott M.L. Cummings, Design Methodology for Unmanned Aerial Vehicle (UAV) Team Coordination, MIT Department of Aeronautics and Astronautics, Cambridge, 2007.

AAE 5252 NAVIGATION, GUIDANCE AND CONTROL [3 1 0 4]

Fundamentals of navigation, guidance and control, Geometric concepts of navigation, Reference frames, coordinate transformation, comparison of transformation methods. Inertial sensors, Inertial navigation systems-Integrated navigation, Fundamentals of radar, satellite navigation system, Classification of Missiles, Guided Missile, Fundamentals of Guidance, Interception and Avoidance, Guidance Laws, Command and Homing Guidance, Classical Guidance Laws, Modern Guidance Laws-Guidance Laws Derived from Optimal Control Theory - PPN with Non-Manoeuvring and Manoeuvring Targets. Applied optimal control and optimal guidance laws; Differential games and pursuit evasion problems; Recent advances in guidance theory; Missile Autopilots, Adaptive Control – Guidance. Functional Block Diagram, Missile Control Methods. Collision detection and avoidance strategies; Applications to guided missiles, unmanned aerial vehicles and Mobile robots, APOLLO guidance and navigation - Spacecraft.

References:

1. Ching-Fang Lin, Modern Navigation, Guidance, and Control Processing, Prentice Hall, 1991.
2. Anthony Lawrence, Modern Inertial Technology: Navigation, Guidance, and Control, 2nd Edition, Mechanical Engineering Series, Springer, 2001.
3. Zarchan P., Tactical and Strategic Missile Guidance (5e), AIAA Series, 2007.
4. Myron Kayton & Walter R. Fried, Avionics Navigation Systems(2e), Wiley-interscience, 1997.
5. Roger W. Pratt, FLIGHT CONTROL SYSTEMS practical issues in design and implementation, Control Engineering Series-57, The Institution of Electrical Engineers and The American Institute of Aeronautics and Astronautics, 2000.
6. Brian L. Stevens, Frank L. Lewis & Eric N. Johnson, Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, 3rd Edition, Wiley-Blackwell, 2015.

AAE 5261 EMBEDDED SYSTEM-SOFTWARE SAFETY AND SECURITY LAB [0 0 3 1]

Group A: Embedded System, Software Development based on ARM Processor etc: Keil Embedded development tools/ μVision, ARM, M-Cortex, Beagle Bone, Arduino, Raspberry Pi, Evaluation board for ARM Cortex-M, PCB Design for embedded system - Eagle/Proteus, FPGA & ASIC, RF Front End Architecture, RTOS, DSP. Group B: Software Safety and Security, standards/certification/testing/LDRA Tools: LDRA Rules, LDRA Cover, LDRA Unit, Session 1: Write a source code in C language, Session 2 Structural Code Coverage Session 3 Unit Testing, Target based Testing

References:

1. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach (2e), MIT Press, 2017.
2. Kai Qian, David den Haring and Li Cao, Embedded Software Development with C, Springer Science and Business Media, LLC, 2009.
3. Michael Barr, Anthony Massa, Programming Embedded Systems, Second Edition with C and GNU Development Tools (2e), O'Reilly Media, 2009.
4. Renu Rajani, Pradeep Oak, Software Testing Effective Methods Tools & Techniques, Tata Mcgraw Hill Publishing Co Ltd, 2017.
5. MISRA C:2012 Standard.
6. SEI CERT C Secure Coding Standard URL: https://www.cert.org/secure-coding/products-services/secure-coding-download.cfm

AAE 5262 WIRELESS COMMUNICATION LAB [0 0 3 1]

Simulation package: Creating the required geometry & its changes in CEM Solutions package, do necessary mesh size, solving the problem with given specification & analyze all required results.

Group A (Antenna Design): Dipole antenna, Dipole Antenna into Yagi-Uda. Rectangular Waveguide for the X- band Satellite Applications. 4. Determination Return loss & Gain of Microstrip. Group B (Wired antennas with placement on electrically large platform): Place the Monopole Antenna analyze the distortion due to the reflections from the UAV body. Understand and analyze the effect of different position of monopole antenna Coupling and Interference between the two monopole antennas, monostatic RCS. Group C Experiment based on Hardware facilities available in lab

References:

1. Balanis C.A, Antenna Theory - Analysis and Design,(4e), John Wiley, 2016.
2. Mathew N O Sadiku, Elements of Electromagnetics,(3e), Oxford University Press, 2001.
3. Thereza Macnamara, Introduction to Antenna Placement and Installation, (1e), Wiley, 2010.
4. John D Kraus, Ronald J Marhefka, Ahmad S Khan, Antennas for All Applications, (3e), The McGraw Hill Companies 2008.
5. Prasad K. D, Antenna & Wave Propagation, Satya Prakashan, New Delhi, 2009.
6. John D Kraus, Antenna & Wave Propagation, (4e), McGraw Hill, 2010.

SEMESTER III and IV

AAE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

AAE 5001 3D MAPPING/PHOTOGRAMMETRY MAPPING SOFTWARE ANALYSIS [3 1 0 4]

Introduction of 3D mapping/Photogrammetry mapping, GIS, Difference Between GIS And Geospatial, Types of Photogrammetry-Aerial Photogrammetry & Close-Range photogrammetry, Output From 3D Maps, Models And GIS, Principles of Photography and Imaging, Cameras and Other Imaging Devices, Image Measurements and Refinements, Object Space Coordinate Systems, Elementary Methods of Planimetric Mapping for GIS, Fundamental Principles of Digital Image Processing, Control for Aerial Photogrammetry, Aero triangulation, Project Planning, Photogrammetry Software: top 10 photogrammetry software for building 3D maps and models using drones on the market, Application: Processing UAV Imagery and its Applications, Remote sensing satellite, surveying, 3D shape analysis techniques and their applications.

References:

1. Paul Wolf, Bon DeWitt, Elements of Photogrammetry with Applications in GIS, (3e), McGraw-Hill Science/ Engineering/ Math, 2000.
2. Hamid Laga, YulanGuo, HediTabia, Robert B. Fisher, MohammedBennamoun, 3D Shape Analysis: Fundamentals, Theory, and Applications, WILEY, 2018
3. Tickoo Sham, Exploring AutoCAD Map 3D 2018, BPB Publications. 2018.
4. Tripp Corbin GISP, Learning ArcGIS Pro, Packt Publishing Limited, 2015.
5. Jai Galliott, Military Robots: Mapping the Moral Landscape, Military and Defence Ethics, 1st Edition, Routledge, 2017.
6. Mahmoud Hassani and James Carswell, Transition from analogue to Digital Photogrammetry, Advances in remote sensing Vol I. No. 3 – VII, 1992.

AAE 5002 ADAPTIVE CONTROL [3 1 0 4]

Introduction, Optimal Control and the Linear Quadratic Regulator, Command Tracking and the Robust Servomechanism, State Feedback H∞ Optimal Control, Adaptive Control: Motivation and Introduction, Lyapunov Stability of Motion, State Feedback Direct Model Reference Adaptive Control, Model Reference Adaptive Control. Discrete-time MPC with Constraints, Discrete-time MPC Using Laguerre Functions, Discrete-time MPC with Prescribed Degree of Stability, Continuous-time Orthonormal Basis Functions, Continuous-time MPC, Continuous-time MPC with Constraints, Continuous-time MPC with Prescribed Degree of Stability, Classical MPC Systems in State-space Formulation, Implementation of Predictive Control Systems

References:

1. Lavretsky, Eugene, Wise, Kevin, Robust and Adaptive Control with Aerospace Applications, Advanced Textbooks in Control and Signal Processing, Springer-Verlag London, 2013.
2. Wang, Liuping, Model Predictive Control System Design and Implementation Using MATLAB, Advances in Industrial Control, Springer-Verlag London, 2009.
3. Eugene Lavretsky, Robust and Adaptive Control: with Aerospace Applications, Advanced Textbooks in Control and Signal Processing, Springer, 2013.
4. Sastry, S.; Bodson, M., Adaptive Control: Stability, Convergence, and Robustness, Dover Publications, Inc.: Mineola, NY, USA, 2011.
5. Whitaker, H.; Yamron, J.; Kezer, A., Design of Model Reference Adaptive Control Systems for Aircraft (Report R-164), MIT Press Instrumentation Laboratory, Cambridge, MA, USA, 1958.
6. Ioannou, P.; Sun, J. Robust Adaptive Control, Dover Publications, Inc.: Mineola, NY, USA, 2012.

AAE 5003 AIRBORNE THERMAL IMAGING SYSTEM [3 1 0 4]

Fundamentals of Infrared Thermal Imaging, Introduction, Infrared Radiation, Radiometry and Thermal Radiation, Emissivity, Optical Material Properties in IR, Thin Film Coatings: IR Components with Tailored Optical Properties, Some Notes on the History of Infrared Science and Technology, Basic properties of IR Imaging systems, Advance methods in IR Imaging, Basic concept of heat transfer, Direct visualization of physics phenomena, shortwave Infrared Thermal Imaging, Application in aerospace and another field. Case Study: Thermal-Infrared Imaging for Earth Science, Photogrammetric Applications, Moistrure Detection, Airborne Reconnaissance Applications, NASA Goddard's LiDAR, Hyperspectral and Thermal (G-LiHT) Airborne Imager, Landsat and Thermal Infrared Imaging, Thermal Remote Sensing with Small Satellites, Challenges and Opportunities for UAV-Borne Thermal Imaging.

References:

1. Vollmer M and Möllmann K. P, Infrared Thermal Imaging: Fundamentals, Research and Applications, (2e), Wiley-VCH, 2018.
2. Claudia Kuenzer and Stefan Dech, Thermal Infrared Remote Sensing Sensors, Methods, Applications, Remote Sensing and Digital Image Processing book series (RDIP, volume 17), Springer, 2013.
3. Lloyd J. M, Thermal Imaging Systems, Optical Physics and Engineering series, Springer, 1975.
4. Gerald C. Holst, Common Sense Approach to Thermal Imaging, SPIE PRESS BOOK, 2000.
5. Wolfe W. L. and Zissis G. J., The Infrared Handbook, revised 4th printing, The Infrared Information Analysis Center, Environmental Research Institute of Michigan, 1993.
6. Sun, Xiuhong; Shu, Peter, An airborne thematic thermal infrared and electro-optical imaging system, Proceedings of the SPIE, Volume 8193, 2011.

AAE 5004 AIRCARFT COMPUTER SYSTEMS AND NETWORKS [3 1 0 4]

Basic functions and facilities of a computer, Computer Systems Hardware, Introduction: Building computers from logic: the ALU, Building computers from logic: the memory, The Intel Pentium CPU, Subroutines, Simple input and output, Serial and Parallel Connections, The memory hierarchy, Storage Devices and Communication, Networking Essentials., Networking Computers, Communications, Data Communications and Transmission Media, The Internet, Aspects of Data Communications and Network Security, Local area networks (LANs), Wide area networks (WANs), Network segments, Intranets, Data Communication Systems, other Network, Operating Systems, Windows XP, Filing systems, Visual output, RISC processors: ARM and SPARC, VLIW processors: the EPIC Itanium, Parallel processing, Case study : Aircraft computers, Aircraft Networking, Aircraft Data Network (ADN),

References:

1. Rob Williams, Computer Systems Architecture - A Networking Approach, (2e), PEARSON Prentice Hall, 2006.
2. Barry G. Blundell, Nawaz Khan, AboubakerLasebaeet al., Computer Systems and Networks, Cengage Learning EMEA, 2007.
3. Irv Englander, The Architecture of Computer Hardware, System Software, And Networking: An Information Technology Approach, John Wiley & Sons, Inc., 2019.
4. Olivier Bonaventure, Computer Networking: Principles, Protocols and Practice Release 0.25, Creative Commons license, 2011.
5. Dale Stacey, Aeronautical Radio Communication Systems and Networks, John Wiley & Sons, Ltd, 2008.
6. Philipp Goedeking, Networks in Aviation: Strategies and Structures, Springer, 2010.

AAE 5005 AIRCRAFT DATABUS [3 1 0 4]

Introduction of databus: civil aircraft, military fighters, spacecraft, unmanned aerial vehicles, types of databuses, Commercial Standard Digital Bus, ARINC, MIL STD, Optical fibre, SAFEbus, Time-Triggered Protocol etc. Data bus, fibre optics, Establishing a New Technology Standard, serial digital bus, digital bus integrity. Time-Triggered Protocol, ARINC: ARINC 429, ARINC 653, ARINC 629, AFDX, Avionics Application Software Standard Interface., Switched Ethernet Testing for Avionics Applications, ARINC-818 Testing for Avionics Applications, other ARINC, MIL STD: MIL-STD-1553B Digital Time Division Command/Resp.onse Multiplex Data Bus: Introduction, Standard, Protocol, Systems-Level Issues, Testing, Integration and application, MIL-STD-1760, MIL-STD-1773, Testing High Speed Ethernet &Fibre Channel Avionics Switches, Considerations for Testing and Simulation of MIL-STD-1760E/HS1760 Avionics Interfaces,

References:

1. Cary R. Spitzer, Digital Avionics Handbook: -Avionics Development and Implementation, (2e), CRC Press, Taylor & Francis Group, 2007.
2. Richard Zurawski, Industrial Communication Technology Handbook, Industrial Information Technology Series, (2e), 2014.
3. GAMA, Commercial Standard Digital Bus (CSDB), General Aviation Manufacture Association, Washington, DC, June 10, 1986.
4. Eldredge, D. and E. F. Hitt, Digital System Bus Integrity, DOT/FAA/CT-86/44, Federal Aviation Administration Technical Centre, Atlantic City International Airport, NJ, March 1987.
5. Elwell, D., L. Hensyl, and N. VanSuetendael, Avionic Data Bus Integration Technology, DOT/FAA/CT-91-19, Federal Aviation Administration Technical Centre, Atlantic City International Airport, NJ, December 1991.
6. Commercial Standard Digital Bus, (8e), Collins General Aviation Division, Rockwell International Corporation, Cedar Rapids, IA, 1991.

AAE 5006 AIRCRAFT ELECTRICAL SYSTEM [3 1 0 4]

Overview of Aircraft Electrical System: Electrical fundamentals, Basic, Electronic fundamentals, digital fundamentals, Electric Measuring Instruments. Aircraft Batteries and other source – Types of Batteries, Battery and Charger Characteristics, Power Supply, Regulator, Inverter, TRU, APU, Emergency power. D. C. Generators, Generator Controls, Generator Controls, D. C. Alternators and Controls, Wiring Installation, Circuit protection, shielding/screening, power distribution, Aircraft Electrical Systems, engine starting, ignition and indicating, fuel management, bus system, charging, standby and essential powers, Control and Transduces-switches, relays, contactors, transducers. Aircraft Lighting Systems, Electrical System Components, Electrical and magnetic field -EM/EMC/lightning, airworthiness.

References:

1. Mike Tooley and David Wyatt, Aircraft Electrical and Electronic Systems: Principles, Operation and Maintenance, Butterworth-Heinemann: Elsevier, 2009.
2. Ian Moir, Allan Seabridge, Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration, (3e), Aerospace Series, Wiley, 2011.
3. Thomas K. Eismin, Aircraft Electricity and Electronics, (6e), McGraw Hill Education(India) Private Limited.
4. EHJ Pallett, Aircraft Electrical Systems, (3e), PEARSON India Education Services Pvt. Ltd, 1997.
5. Cary R. Spitzer, Digital Avionics Handbook: -Avionics Development and Implementation, (2e), CRC Press, Taylor & Francis Group, 2007.
6. Len Buckwalter, Avionics Training: Systems, Installation and Troubleshooting, Avionics Communications Inc., 2005

AAE 5007 ANTENNA DESIGNING, SIMULATION AND PLACEMENT FOR AEROSPACE [3 1 0 4]

Fundamentals of Antenna, Basic Antenna and Propagation Theory: Introduction, Characteristics of Electromagnetic Waves, Interaction between Two Wave Polarizations, Vertical & Horizontal Polarization. Characteristics of an Antenna. Propagation. Antennas and Applications: Structural details, dimensions, radiation pattern, specifications, features and applications of antennas. Antennas Placement/Used on Aircraft: Introduction, Near and Far Fields of an Antenna, Antennas on Aerospace/UAV structures, Polar Radiation Patterns., Computer Modelling Techniques: Computer Modelling, Generic Types of Computer Modelling, Method of Moments, FDTD, UTD, Physical Optics, Hybrid Methods, Radar Cross Section (RCS): Introduction of RCS, Classification of RCS, RCS of Simple & Complex Objects, RCS Dependency on Polarization, Stealth technology and radar absorbing materials (RAM). Aircraft antenna design and analysis using software.

References

1. Balanis C. A, Antenna Theory - Analysis and Design, (4e), John Wiley, 2016.
2. Mathew N O Sadiku, Elements of Electromagnetics, (3e), Oxford University Press, 2001.
3. Thereza Macnamara, Introduction to Antenna Placement and Installation, Wiley, 2010.
4. John D Kraus, Ronald J Marhefka, Ahmad S Khan, Antennas for All Applications, (3e),The McGraw Hill Companies, 2008.
5. Rhodes J. E, Antenna Handbook, Department of the Navy, 2016.
6. Lo, Y. T., Lee, S. W., Antenna Handbook Theory, Applications, and Design, Springer US, 1988.

AAE 5008 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING [3 1 0 4]

Artificial Neural Network: Introduction, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feed forward network, Back propagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Types of learning, Self-Organizing Feature Maps Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of GA, analysis of selection operations, Hybrid Systems: Neural-Network-Based Fuzzy Systems, Genetic Algorithm for Neural Network Design and Learning, Machine Learning and data science: Machine learning, pattern recognition, image processing, text processing, natural language processing, graphics, cognition and computation, data mining, Introduction to Computer Vision: Edge detection, Point Correspondence and Stereopsis, Surface directions, Expert Systems: fundamental blocks, case studies in various domains, Intelligent System Applications: Intelligent Systems for Search and modelling, Automated Training Using an Intelligent System, Intelligent Systems for Control,

References:

1. Neural Networks, Fuzzy logic and Genetic Algorithms, Synthesis and applications by S. Rajsekharan, Vijayalaxmi Pai Russell S. and Norvig P. 1995.
2. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.
3. Holland, J. H. Adaption in Natural and Artificial Systems, University of Michigan Press 1975.
4. Neural Fuzzy Systems, Chin-Teng Lin & C. S. George Lee, Prentice Hall PTR.
5. Genetic Algorithms in Search and Optimization, and Machine Learning, D. E. Goldberg, Addison Wesley, 1989.
6. Schalkoff, R. J. Artificial Intelligence: An Engineering Approach, McGraw Hill, New York 1990 .

AAE 5009 CRYPTOLOGY, CRYPTOGRAPHY AND CRYPTOANALYSIS [3 1 0 4]

Cryptology: The fundamentals of codes, ciphers, and authentication, Cryptology in private and commercial life, Cryptography: Overview of Cryptography, Mathematical Background, Number-Theoretic Reference Problems, Public-Key Parameters , Pseudorandom Bits and Sequences, Cipher systems, Key cryptosystems, Block and stream ciphers, Public-Key Encryption, Hash Functions and Data Integrity, Identification and Entity Authentication, Digital Signatures, Key Establishment Protocols, Key Management Techniques, Efficient Implementation, Patents and Standards. Cryptanalysis: Basic aspects, Types of cryptanalysis, History of cryptology, Early cryptographic systems and applications, Developments during World Wars I and II, The impact of modern electronics, The Data Encryption Standard and the Advanced Encryption Standard

References:

1. Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, Handbook of Applied Cryptography, 1st Edition, CRC Press, 1996.
2. Gustavus J. Simmons (Ed.), Contemporary Cryptology: The Science of Information Integrity, 1992.
3. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, (2e) 1996.
4. Alfred J. Menezes, Paul C. Van Oorschot, and Scott A. Vanstone, Handbook of Applied Cryptography, 1997.
5. A. J. Menezes, P. van Oorschot and S.A. Vanstone. The Handbook of Applied Cryptography. CRC Press, 1997.
6. Davis Chapman, Developing Secure Applications with Visual Basic, Sams, 2000.

AAE 5010 DECISION SUPPORT SYSTEM IN AEROSPACE APPLICATION [3 1 0 4]

Foundations of Decision Support Systems, Management Support Systems: An Overview, Decision-Making Systems, Modeling, and Support, Decision Support System Fundamentals, Overview, Modeling, Business Intelligence: Data Warehousing, Data Acquisition, Data Mining, Business Analytics, and Visualization, Multiparticipant Decision Support Systems,

Intelligent Decision Support Systems- Artificial Intelligence and Expert Systems: Knowledge-Based System, Advanced Intelligent Systems, Intelligent Systems Over the Internet, Time and Space Issues for Decision Support, Decision Support Systems, Decision Support Cases and Applications, Decision Support Horizons, Applications of Decision Support System in Aviation Maintenance, Decision Support System for Fighter Pilots, Decision support in fighter aircraft, UAV - Human Interfaces and Decision Support Systems, Cognitive Task Analysis for Unmanned Aerial System Design, Display and Control

References:

1. Burstein, Frada; Holsapple, Clyde W., Handbook on Decision Support Systems 1: Basic Themes, Berlin Germany: Springer-Verlag London Ltd., 2008.
2. Efraim Turban Jay E. Aronson Ting-Peng Liang, Decision Support Systems and Intelligent Systems, (7e), Prentice Hall, 2004.
3. Chiang S. Jao, Decision Support Systems, first published, Intech, 2010.
4. Kimon P. Valavanis, George J. Vachtsevanos, Handbook of Unmanned Aerial Vehicles, Springer, Dordrecht, 2015.
5. Xiaoqian Sun, Volker Gollnick, Yongchang Li, and Eike Stumpf. Intelligent Multicriteria Decision Support System for Systems Design, Journal of Aircraft, Vol. 51, No. 1 (2014), pp. 216-225.
6. Holsapple, Clyde, Whinston, Andrew B. (Eds.), Decision Support Systems: Theory and Application, Springer, Berlin, Heidelberg, 1987.

AAE 5011 DIGITAL AND ANALOG COMMUNICATION [3 1 0 4]

Introduction, communication process, source, channel, modulation process, ADC, DAC, Signals and Signal Space, signal classification, functions, Analysis and Transmission of Signals, Fourier series, Fourier transform, energy signal, power signal, correlation and auto correlation, Application, Amplitude Modulations and Demodulations, SSB, DSB-SC, VSB, Angle Modulation and Demodulation, PM, FM, Wideband FM, demodulators or detectors, Fundamentals of Probability Theory, Random Processes and Spectral Analysis, Noises, Performance of communication systems, AM and FM Receiver, sampling theory, Introduction to Information Theory, Error Correcting Codes, Spread Spectrum Communications, Cellular and mobile communication, Security in Next Generation Air Trac Communication Network, Aircraft communication, satellite communication etc.

References:

1. Lathi B. P., Ding Z., Modern Digital and Analog Communication Systems, Oxford University Press, 2010.
2. Haykin S., Communication Systems, Wiley India Edition, 2009.
3. Proakis, John G.; Salehi, Masoud, Communication systems engineering, Prentice Hall, 2002.
4. Sklar, Bernard, Digital communications: fundamentals and applications, Prentice Hall, 2001.

5. Sanjay Sharma, Communication system (Analog and Digital), S.K. Kataria & Sons, 2013.
6. Carlson, A. Bruce; Rutledge, Janet C.; Crilly, Paul B., "Communication systems: an introduction to signals and noise in electrical communication", McGraw-Hill, New York 2002.

AAE 5012 DIGITAL CONTROL SYSTEM [3 1 0 4]

Introduction to Digital Control, Modeling of Digital Control Systems, Digital Control System Design, State Space Representation, Optimal Control: Optimization, Unconstrained, optimization, Constrained optimization, linear quadratic regulator, Hamiltonian system Eigenstructure of the Hamiltonian matrix, Elements of Nonlinear Digital Control Systems, Practical Issues Design of the hardware and software architecture, Software requirements, filters, Controller structure, Sampling period switching, MATLAB commands, Computer Control Systems, Introduction to Computer Control, Robust Digital Controller Design Methods, Digital PID Controller, System Model Simulation of a digital aircraft flight control system, A new method, Digital Adaptive Flight Control System for Aerospace Vehicles.

References:

1. Sami Fadali, Antonio Visioli, Digital Control Engineering Analysis and Design, Second Edition, Elsevier Inc, 2013.
2. IoanDoré Landau, GianlucaZito, Digital Control Systems: Design, Identification and Implementation Communications and Control Engineering, Springer Science & Business Media, 2007.
3. Charles L. Philips, H. Troy Nagle, Digital Control System Analysis and Design, (3e), Prentice-Hall, Inc, 1995.
4. M Gopal, Digital Control and State Variable Methods, Conventional and Neural-Fuzzy Control Systems, (6e), Tata McGraw-Hill, Delhi, 2003.
5. Karl Johan Aström, Richard M. Murray, Feedback Systems, An Introduction for Scientists and Engineers, (3e), Princeton University Press, 2010.

AAE 5013 DIGITAL FLY-BY WIRE CONTROL [3 1 0 4]

Introduction, Fly-by-Wire Principles, Evolution, DFBW technology: Space shuttle, Lunchers, Airbus -320, Boeing-777/787, Jet fighters, stealth bomber, Rotorcrafts and Unmanned aerial vehicles, Main System Features Computer Arrangement, Failure Detection and Reconfiguration, Flight Control Laws, Major benefits of DFBW flight controls include: Overall cost reduction, Overall airframe weight reduction, Increased safety and reliability, Fuel emissions, Improved flying (or handling) qualities, Improved mission performance, Reconfigurable flight control system, safe recovery, system failures, Fly-by-Wireless, Intelligent Flight Control System, A320 Experience, A380 Flight Controls overview, Boeing-777/787 Flight Control system overview.

References:

1. Cary R. Spitzer, Uma Ferrell and Thomas Ferrell and Associates Consulting, Inc. Thomas Ferrell, Digital Avionics Handbook, (3e), CRC Press Taylor & Francis Group, LLC, 2015.
2. Cary R. Spitzer, Digital Avionics Handbook: -Avionics Development and Implementation, 2nd Edition, CRC Press, Taylor & Francis Group, 2007.
3. Ian Moir; Allan G. Seabridge; Malcolm Jukes, Civil Avionics Systems, London (iMechE): Professional Engineering Publishing Ltd, 2003.
4. Collinson R.P.G., Introduction to Avionics, Springer US, 2003.
5. Mirza, N.A., Primary Flight Computers for the Boeing 777, ERA Avionics Conference 1992, ERA Report 92–0809.
6. C. Droste, J. Walker, The General Dynamics Case Study on the F-16 Fly-By-Wire Flight Control System, Case Studies Series, AIAA, 2003.

AAE 5014 DIGITAL IMAGING SENSORS [3 1 0 4]

Introduction of digital Image Sensor, Basics of Image Sensors, Digital Still Cameras at A Glance, Basic Structure of Digital Still Cameras, Applications of Digital Still Cameras, main types: CCD & CMOS, CCD Image Sensor vs. CMOS Image Sensor, Light and CCD/CMOS sensor fundamentals, CCD and CMOS Sensors-Fundamentals of CCD & CMOS image sensors, Smart functions and materials, Smart imaging, Camera Interface Standards: GigE Vision (Gigabit Ethernet - GigE), DCAM (FireWire - IEEE 1394), Camera Link (Framegrabber), Camera Link HS, CoaXPress, USB3 Vision, GenICam, Interface Comparison, Camera Types and when to use: Area scan, Line scan, imaging-spectroscopy, Machine vision/sensing, UV Spectroscopy, Test and Evaluation of Space and Airborne Imaging Sensor Platforms,

References:

1. Jun Ohta, Smart CMOS Image Sensors and Applications, Series: Optical Science and Engineering, CRC Press, 2007/2008.
2. Junichi Nakamura, IMAGE SENSORS and SIGNAL PROCESSING for DIGITAL STILL CAMERAS, CRC Press, Taylor & Francis Group, 2006.
3. S. SitharamaIyengar, Richard R. Brooks, Distributed Sensor Networks, Image and Sensor Signal Processing (Volume One), (2e), Chapman & Hall/CRC Computer and Information Science Series, 2016.
4. Takao Kuroda, Essential Principles of Image Sensors, CRC Press, 2017.
5. RastislavLukac, Single-Sensor Imaging: Methods and Applications for Digital Cameras, Image Processing Series, 2008.
6. Ron Graham, The Digital Image, (2e), Whittles Publishing, 2005.

AAE 5015 DIGITAL SIGNAL PROCESSING [3 1 0 4]

Introduction of DSP, The Breadth and Depth of DSP, The Roots of DSP, Telecommunications, Audio Processing, Echo Location, Image Processing, Aerospace signal processing - Radar, sonar, electronic warfare, Signal intelligence (SIGINT), Sensor processing to enable situational awareness.

Statistics, Discrete Fourier Transform, Introduction to Digital Filters, Signal processing- Audio Processing, Image Formation & Display, Digital Signal Processors, Complex Techniques, Design projects, digital signal processing for improving SIGINT and cyber security, radar signal, DSP systems by Coreel technology, Abaco, Orolia, Aitech, Rohde &Swarz, Pentek, Annapolis & TE, X-ES, Kontron etc.

References:

1. Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing, (2e), California Technical Publishing, 1999.
2. C. Ramesh Babu, Digital Signal Processing, (4e), Scitech Publications Private Limited, 2007.
3. Proakis, John G.; Manolakis, Dimitris G, Introduction to digital signal processing, Collier MacMillan, 1988.
4. Oppenheim, Alan V.; Schafer, Ronald W, Discrete-time signal processing, 3rd. Upper Saddle River (N.J.): Prentice-Hall, 2010.
5. Proakis, John G.; Salehi, Masoud, Communication systems engineering, 2nd. Upper Saddle River, New Jersey: Prentice Hall, 2002.
6. Sklar, Bernard, Digital communications: fundamentals and applications, 2nd. Upper Saddle River: Prentice Hall, 2001.

AAE 5016 ELECTRO OPTIC SYSTEMS [3 1 0 4]

Introduction to Electro-optic and Infrared (EO/IR) Systems Engineering, Electro-Optics (EO) - generation, modulation, detection, measurement, and display, Radiation in the Visible and Infrared, Electromagnetic Spectrum, EMFT in EO, Radiation Sources, Genesis of electro-optic systems, Electro-Optic and Infrared Systems, Components, Electro-Optical Systems Design, Analysis, and Testing, Laser Imaging Systems Spectral Imaging, Detection, Resolution, and Recognition, Lasers, Detector Characteristics, Image and Camera Tubes, Signal modulation schemes in optical, Forward error correction coding, Photographing E-O Displays, LIDAR and LADAR, Optical Communications Systems, Modern communications designs for FOC/FSOC applications, General LIDAR ranging, Medical Imaging, Optical Systems in Space, An Integrated Electro-Optical Payload System for Forest Fires Monitoring from Airborne Platform

References:

1. Joseph S. Accetta, David L. Shumaker, The Infrared and Electro-Optical Systems Handbook, (S. R Robinson, Emerging Systems and Technologies, Volume 8), Infrared Information Analysis Center & SPIE, 1993.
2. Sherman Karp, Larry B. Stotts, Fundamentals of Electro-Optic Systems Design: Communications, Lidar, and Imaging, Cambridge University Press, 2013.
3. William Wolfgang Arrasmith, Systems Engineering and Analysis of Electro-Optical and Infrared Systems, Taylor & Francis Inc, 2015.
4. Mark A. Mentzer, Applied Optics Fundamentals and Device Applications: Nano, MOEMS, and Biotechnology, CRC Press, 2017.
5. Davis Christopher, C. Davis, Lasers and Electro-optics: Fundamentals and Engineering, (2e), Cambridge University Press, 1996.
6. Barbara G. Grant, Getting Started with UAV Imaging Systems: A Radiometric Guide, Volume: PM270, SPIE Digital Library, 2016.

AAE 5017 EMBEDDED SYSTEMS: SOFTWARE SAFETY AND SECURITY OF EMBEDDED SYSTEM[3 1 0 4]

Introduction of Embedded System, Embedded processor, Memory system, peripherals, Interfacing, Software Development based on ARM Processor etc, Development of autopilot, Effective software development for aerospace safety and critical application, software development and testing, requirement analysis, SDLC & Fundamentals of Software Testing /Embedded System, Introduction to Coding, Introduction to Process Standard DO-178C for Avionics, Lab Session 1 (Static Analysis, SW Quality & Secure Coding Standards Compliance), Lab Session 2 (Structural Code Coverage), Lab Session 3 (Unit Testing, Target based Testing).

References:

1. Lee E. A. and Seshia S. A., Introduction to Embedded Systems - A Cyber-Physical Systems Approach, (2e), MIT Press, 2017.
2. Kai Qian, David den Haring and Li Cao, Embedded Software Development with C, Springer Science and Business Media, LLC, 2009.
3. Michael Barr, Anthony Massa, Programming Embedded Systems, Second Edition with C and GNU Development Tools, (2e), O'Reilly Media, 2009.
4. Renu Rajani, Pradeep Oak, Software Testing Effective Methods Tools & Techniques, Tata Mcgraw Hill Publishing Co Ltd, 2017.
5. MISRA C:2012 Standard
6. SEI CERT C Secure Coding Standard

AAE 5018 GROUND AIRPORT NAVIGATION AND COMMUNICATION SYSTEM [3 1 0 4]

Radio frequency spectrum, electromagnetic wave, wavelength and frequency, radio wave propagation, Modulation Techniques, Antenna Systems: Purpose, Terminology, Types of Antenna, Wireless Beacon System: Types, Airborne And Ground Equipment's, Antenna, VOR, Doppler VOR (DVOR), Theory, Effects, Interference, Phasing, Blocks Diagram, Instrument Landing System, Microwave Landing System, Transponder Landing System, Tactical Air Navigation System: Principle, TACAN Antenna, Conjugation with VOR/DME, TACAN, VORTAC, Signal Characteristics, Siting Criteria of Airport Ground Navigational Systems: Standards and Recommended Practices (SARPS), Siting Criteria for NDB, VOR, DVOR, ILS, GP, BEACON, DME, TLS. Communication: ARINC, VHF communication system, AIRCOM, ACARS, SATCOM, ATC etc.

References:

1. Arjun Singh, Airport Ground Navigation Systems, McGraw Hill Education (India) Private Limited, New Delhi, 2012.
2. Mike Tooley and David Wyatt, Aircraft Communications and Navigation Systems: Principles, Operation and Maintenance, Elsevier, USA, 2007.
3. Dale Stacey, Aeronautical Radio Communication Systems and Networks, Wiley, 2008.
4. Mike Tooley and David Wyatt, Aircraft Communications and Navigation Systems, (2e), Routledge, 2017.
5. Mike Tooley BA and David Wyatt, Aircraft Communications and Navigation Systems: Principles, Maintenance and Operation, Butterworth-Heinemann, 2007.
6. Sanjay Sharma, Communication Systems (Analog and Digital), S.K. Kataria& Sons, 2013.

AAE 5019 HUMANOID ROBOTS [3 1 0 4]

History of Humanoid, Humanoid Mechanism and Design (HMD), Humanoid Kinematics and Dynamics (HKD), Humanoid Control (HC), Humanoid Balance (HB), Humanoid Motion Planning, Optimization and Gait Generation, Humanoid Simulation and software (HSS), Human-Humanoid Interaction (HHI), Applications of Humanoids (HApp), Development Story of 15 Famous Humanoid Robots (H15), Humanoid Sensing, Actuation and Intelligence, Cognitive Intelligence and Robots, Robotic frameworks and middleware, Robotic architectures: AuRA, BERRA, DCA, Saphira, GenoM.

References:

1. Ambarish Goswami, Prahlad Vadakkepat, Jong-Hwan Kim, Humanoid Robotics: A Reference, Springer-Verlag/Sci-Tech/Trade, 2018.
2. Ben Choi, Humanoid Robots, Intech Open, 2009.
3. DragomirNenchev Atsushi Konno TeppeiTsujita, Humanoid Robots: Modeling and Control, Butterworth-Heinemann, 2018.
4. RiadhZaier, The Future of Humanoid Robots –Research and Applications, InTech, 2011.
5. Konar, Amit, Pedrycz, Witold, Cognitive Intelligence and Robotics, Springer, ISSN: 2520-1956.
6. Brad Miller, Ken Streeter, Beth Finn, Jerry Morrison, C/C++ Programming Guide for the FIRST Robotics Competition, Rev 0.5, FIRST, 2008.

AAE 5020 IMAGE PROCESSING AND COMPUTER VISION [3 1 0 4]

Introduction and Difference between Computer Vision, Image Processing and Machine Learning? Introduction to Digital Image Processing, Digital Image representation, Mathematical Tools for Image

Processing, Image Enhancement in Spatial Domain, Introduction, what is computer vision? Image formation, Image processing, Feature detection and matching, Segmentation, Feature-based alignment, Structure from motion, Dense motion estimation, Image stitching, Computational photography, Stereo correspondence, 3D reconstruction, Image-based rendering, Recognition. Computational Sensors: Vision VLSI. Processing of Face Images and Its Applications. Document Analysis and Recognition. Recent Progress in Medical Image Processing-Virtualized Human Body and Computer-Aided Surgery. Image Processing for Intelligent Transport Systems. Omnidirectional Sensing and Its Applications.

References:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, Digital Image Processing and Computer Vision, Cengage Learning, 2008.
2. VipinTyagi, Understanding Digital Image Processing, CRC Press, 2018.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.
4. John C. Russ and J. Christian Russ, Introduction to Image Processing and Analysis, CRC Press.
5. John C. Russ, F. Brent Neal, The Image Processing Handbook, (7e), CRC Press, 2017.
6. KiyoharuAizawa, Katsuhiko Sakaue, YasuhitoSuenaga, Image Processing Technologies: Algorithms, Sensors, and Applications, Series: Signal Processing and Communications, CRC Press, 2004.

AAE 5021 KALMAN FILTER AND APPLICATIONS [3 1 0 4]

Linear dynamics systems, their solutions, controllability and observability, Stochastic differential equations, shaping filter, state augmentation, covariance propagation equation, orthogonality principle, linear optimal filters and predictors, Kalman Filter, Kalman-Bucy filter, optimal linear predictors, noise sources and correlation, Riccati equation, relationship, nonlinear applications estimation problems, linearization method, Method of Least Squares, Recursive Least-Squares Filtering, Polynomial Kalman Filters, Continuous Polynomial Kalman Filter, Extended Kalman Filtering, Assorted Techniques for Improving Kalman-Filter Performance, Chain-Rule and Least-Squares Filtering, State-Dependent Riccati Equation Filter, Unscented Kalman Filter, Application of Kalman filter.

References:

1. Grewal, Mohinder, S. Andrews, Angus P., Kalman Filtering Theory and Practice Using MATLAB, (4e,) John Wiley & Sons, Inc, 2014.
2. Zarchan, Paul, Musoff, Howard, Frank K. Lu, Fundamentals of Kalman Filtering: A Practical Approach, (4e), Astronautics and Aeronautics, AIAA, 2013.
3. Grewal, Mohinder, S., Andrews, Angus P. Bartone, Chris G. Global Navigation Satellite Systems, Inertial Navigation, and Integration, (3e), John Wiley & Sons, Inc, 2013.
4. Haykin, Simon, S., Kalman Filtering and Neural Networks, John Wiley & Sons, Inc, 2001.
5. Schmidt S. F. , The Kalman filter: Its recognition and development for aerospace applications, AIAA J. Guid. Contr., vol. 4, pp. 4–7, 1981.
6. Bar-Shalom, Yaakov, Li, Xiao-Rong, Estimation and Tracking: Principles, Techniques, and Software, YBS Publishing, 1998.

AAE 5022 MEMS / MMIC IN AEROSPACE APPLICATION [3 1 0 4]

MEMS Theory, Design and Fabrication: Overview of Microelectromechanical Systems and Microstructures in Aerospace Applications, mechanical properties of MEMS materials, modeling and simulation of MEMS, MMIC Theory, Design, Simulation and Fabrication: Introduction, advantages and disadvantages, application, device technology, Device and fabrication Technology: substrate, transistor, passive components, CAD Techniques, MEMS & MMIC Applications: overview of current, emerging, and possible future MEMS/MMIC applications in aerospace. Microelectromechanical Systems for aerospace and Spacecraft Communications and many others applications

References:

1. Mohamed Gad-el-Hak, The MEMS Handbook - 3 Volume Set, Mechanical and Aerospace Engineering Series, (2e), CRC Press, 2005.
2. Steve Marsh, Practical MMIC Design, Artech House Publishers, 2006.
3. Robert Osiander, M. Ann Garrison Darrin, John L. Champion, MEMS and Microstructures in Aerospace Applications, CRC Press Taylor & Francis Group, 2006.
4. Robertson I.D., Lucyszyn S., RFIC and MMIC Design and Technology, Materials, Circuits and Devices Series, (2e), The Institution of Engineering and Technology, 2001.
5. Mohamed Gad-el-HakThe, MEMS Handbook: MEMS Design and Fabrication, (2e), Taylor & Francis Group, LLC, 2014.
6. Reza GhodssiPinyen Lin, MEMS Materials and Processes Handbook, MEMS Reference Shelf book series, Springer Nature, 2018.

AAE 5023 MISSILE GUIDANCE [3 1 0 4]

Numerical technique: Solution of differential equation, laplace transform, numerical integration, Z transform, Difference equation. Tactical missile guidance: Proportional navigation, simulation in 2D, Engagement solution, linearization, closed form solution, zero miss distance. Methods of adjoint and Homing loop, Noise analysis, Proportional Navigation and other Guidance, Ballistic target properties, Extended Kalman filtering and ballistic coefficients estimation, ballistic target challenges, multiple targets, Weaving targets , problem formulation, closed form solution, Missile airframe and mathematical model, force and moment derivation, linearization, Flight control design and interaction with guidance system, Other methods for guidance laws development, Differential game guidance laws development.

References:

1. Paul Zarchan, Tactical and Strategic Missile Guidance, Sixth Edition, American Institute of Aeronautics and Astronautics, Inc, 2012.
2. N. A. Shneydor, Missile Guidance and Pursuit: Kinematics, Dynamics and Control, Horwood Series in Engineering, Horwood Publishing Ltd, 1998.
3. Warren J. Boord, John B. Hoffman, Air and Missile Defense Systems Engineering, CRC Press, 2016.
4. Joseph Carleone, Tactical Missile Warheads, American Institute of Aeronautics & Astronautics, Inc, 1993.
5. Ashton B. Carter, David N. Schwartz, Ballistic Missile Defense, Brookings Institution, 1984.
6. Peter H. Zipfel, Modeling and Simulation of Aerospace Vehicle Dynamics, (3e), AIAA Education Series, American Institute of Aeronautics & Astronautics, 2014

AAE 5024 OPTIMAL CONTROL [3 1 0 4]

Nonlinear optimization, Formulation of optimal control problems, Parameter optimization versus path optimization, Local and global optima; general conditions on existence and uniqueness. Some basic facts from finite-dimensional optimization, the Euler-Lagrange equation, path optimization subject to constraints, weak and strong extrema, Calculus of variations applied to optimal control, Pontryagin's minimum principle, Optimal control with state and control constraints, Time-optimal control, Singular solutions, Hamilton-Jacobi-Bellman (HJB) equation and dynamical programming, Finite-time and infinite-time state (or output) regulators, Riccati equation and its properties, Tracking and disturbance rejection, Kalman filter and duality, The LQR design, The LQG design, ESTIMATORS/OBSERVERS:-MIMO System and SVD, Holonomic &Nonholonomic System Optimal Control, Game Theoretic Optimal Control Design, Signals and system norms.

References:

1. Bryson A.E. and Ho, Y.C. Applied Optimal Control, 2nd ed., Blaisdel., 1975.
2. Naidu D. S., Optimal Control Systems, CRC Press, 2002.
3. Sinha A., Linear Systems: Optimal and Robust Control, CRC Press, 2007.
4. Athans M. and Falb P. L., Optimal Control, McGraw Hill, 2007.
5. Kirk D. E. , Optimal Control Theory: An Introduction, Prentice-Hall, 2004.
6. Dimitri P. Bertsekas, Dynamic Programming and Optimal Control, Volume I, (3e), Athena Scientific, 2005.

AAE 5025 PRACTICAL CRYPTOGRAPHY IN C/C++ [3 1 0 4]

Basics of Security and Cryptography, what is encryption and Decryption, Types of algorithms, Encryption vulnerabilities, Classical Cryptographic Algorithms, Rotor Machine, Block Cipher, Data Encryption Standard, Advanced Encryption Standard, Asymmetric Key Algorithms, The RSA Algorithm, Elliptic Curve Cryptography, Message Digest Algorithm, Secure Hash Algorithm, Fundamentals of Identity-Based Cryptography, Symmetric Key Encryption Acceleration on Heterogeneous Many-Core Architectures, Methods and Algorithms for Fast Hashing in Data Streaming, Arithmetic and Number Theory in C, Introduction, Number Formats, Modular Arithmetic, Where All Roads Meet, A Successor, Large Random Numbers, Strategies for Testing LINT, The LINT Public Interface: Members and Friends, An Application Example: The RSA Cryptosystem.

References:

1. Saiful Azad, Al-Sakib Khan Pathan, Practical Cryptography: Algorithms and Implementations Using C++, Auerbach Publications 2014.
2. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Ed., 1996.
3. Menezes A.J., P. van Oorschot and S.A. Vanstone. The Handbook of Applied Cryptography. CRC Press, 1997.
4. Robert C. Seacord, Secure Coding in C and C++, Addison-Wesley Professional, 2005.
5. John Viega and Matt Messier, Secure Programming Cookbook for C and C++, O'Reilly, 2003.
6. George Loukas, Cyber-Physical Attacks: A Growing Invisible Threat, Butterworth-Heinemann, 2015.
7. Welschenbach, Michael, Cryptography in C and C++, Apress, 2005.

AAE 5026 PROGRAMMING LANGUAGES FOR IMAGE PROCESSING AND COMPUTER VISION ALGORITHM [3 1 0 4]

Introduction to Digital Image Processing and Analysis, Digital Image Analysis and Computer Vision, Digital Image Processing And Human Vision: Image Algebra, Image Enhancement Techniques, Edge Detection and Boundary Finding Techniques, Thresholding Techniques, Thinning And Skeletonizing, Connected Component Algorithms, Fundamental Tools for Image Processing and Analysis: Application Development with the MATLAB CVIP Toolbox and CVIPTOOLS- MATLAB CVIP Toolbox and CVIPlab, C/C++, Introduction to OpenCV and OpenCV3's Python API. Develop a computer vision application using above software for making an object disappear from an image, identifying different shapes, reconstructing a 3D map from images, and building an augmented reality, hand gesture recognition, tracking visually salient objects, as well as recognizing traffic signs and emotions on faces, Medical Imaging Systems,

[80% should be algorithm discussion than theory.]

References:

1. Scott E Umbaugh, Digital Image Processing and Analysis: Applications with MATLAB and CVIPtools, (3e), CRC Press, 2017.
2. Artyom M. Grigoryan, Merughan M. Grigoryan, Image Processing: Tensor Transform and Discrete Tomography with MATLAB, 1st Edition, CRC Press, 2018.
3. Joseph Howse, Prateek Joshi, Michael Beyeler, OpenCV: Computer Vision Projects with Python, Packt Publishing Limited, 2016.
4. Omer Demirkaya, Musa H. Asyali, Prasanna K. Sahoo, Image Processing with MATLAB: Applications in Medicine and Biology, CRC Press, 2008.
5. Joseph N. Wilson, Gerhard X. Ritter, Handbook of Computer Vision Algorithms in Image Algebra, 2nd edition, CRC Press, 2000.
6. Abhinav Dadhich, Practical Computer Vision: Extract insightful information from images using TensorFlow, Keras, and OpenCV, Packt Publishing Limited, 2018.

AAE 5027 RADAR [3 1 0 4]

An Introduction and Overview of Radar, Airborne Radar, Fundamentals of Radar, MTI Radar, Airborne MTI, Pulse Doppler Radar, Sea Clutter, Ground Echo, Multifunctional Radar Systems for Fighter Aircraft, Radar Receivers, Automatic Detection, Tracking, and Sensor Integration, Pulse Compression Radar, Tracking Radar, The Radar Transmitter, Solid-State Transmitters, Reflector Antennas, Phased Array Radar Antennas, Radar Cross Section, Synthetic Aperture Radar, Air-to-Air operation, Imaging Radar, Space-Based Remote Sensing Radars, Meteorological Radar, HF Over-the-Horizon Radar, Ground Penetrating Radar, Civil Marine Radar, Bistatic Radar, Radar and Electronic Warfare: Electronic Counter-Countermeasures, Radar Digital Signal Processing, The Propagation Factor, F p, in the Radar Equation, Representing Radar systems, Aviation weather surveillance systems, advanced radar and surface sensors for flight safety and air traffic management.

References:

1. Merrill I. Skolnik, Radar Handbook, (3e), McGraw-Hill, New York, New York, USA, 2008.
2. Stimson, George W.; Griffiths, Hugh D.; Baker, Chris J.; Adamy, Dave, Introduction to Airborne Radar, (3e), Aerospace & Radar Technology, Institution of Engineering and Technology, 2014.
3. Martin Schetzen, Airborne Doppler Radar, The American Institute of Aeronautics and Astronautics, Inc, 2006.
4. George W. Stimson, Introduction to Airborne Radar, Aerospace & Radar Systems, (2e), SciTech Publishing, 1998.
5. William L. Melvin, James A. Scheer, Principles of Modern Radar: Advanced techniques, Electromagnetics and Radar, SciTech Publishing, 2012.
6. Busyairah Syd Ali, Aircraft Surveillance Systems Radar Limitations and the Advent of the Automatic Dependent Surveillance Broadcast, Taylor and Francis Books Limited U.K., 2018.

AAE 5028 REAL TIME DATA TELEMETRY DEVELOPMENT AND APPLICATION [3 1 0 4]

ntroduction to Telemetry: Principles, classification and importance of telemetry, Telemetry system, remote control, remote signaling, Signals and Transmission, digital modulation, Transmitters and Receivers, Digital communication systems, spread spectrum communication system, Signal Transmission Media, Antennas and Link analysis: Telemetry link RF system design, synchronization, Hybrid Systems, error detecting & correcting codes, Industrial telemetry. Supervisory Control & Data Acquisition, Important Applications: Defense, space and resource exploration, , Rocketry, Flight testing, Military intelligence, Testing, Communications, Mining, Software, Meteorology, Transportation, Water management, Energy monitoring, Resource distribution, Medicine/healthcare.

References:

1. Dr. Frank Carden, Dr. Robert Henry, Dr. Russ Jedlicka, Telemetry Systems Engineering, Subsequent Edition, Artech House Telecommunications Library, 2002.
2. Elliot L Gruenberg, Handbook of telemetry & Remote Control, First Edition, McGraw-Hill Education, 1967.
3. Foster, Leroy, Telemetry Systems, John Wiley & Sons, New York, 1965.
4. Dr. Frank Carden, Telemetry Systems Design, Artech House, 1995
5. Stacey, D. Aeronautical Radio Communication Systems and Networks. Chichester: John Wiley & Sons Ltd, 2008.
6. John G. Webster, Measurement, Instrumentation, and Sensors Handbook, CRC Press LLC, 1999.

AAE 5029 RF AND MICROWAVES ENGINEERING [3 1 0 4]

Introduction: Radiofrequency and Microwave Applications, Frequency Bands, Physical,Electromagnetic Fields and Waves:, Transmission Line Theory and Transient Signals on Lines, Transmission Lines and Waveguides, Scattering Parameters, S-Parameter Measurement, RF Components and Circuits, Filter,Transmission Line Filter, Coupler, Balanced to Unbalanced Circuits, Electronic Circuits, Amplifiers and Oscillators, RF Design Software-RF Circuit Simulators, Three-Dimensional Electromagnetic Simulators, Antennas: Fundamental Parameters, Standard Types of Antennas, Modern Antenna Concepts, Radio Wave Propagation: Propagation Mechanisms, Basic Propagation Models, Path Loss Models

References:

1. Joseph H. White, High Frequency Techniques: An Introduction to RF and Microwave Design and Computer Simulation, John Wiley and Sons U.S.A., 2016.
2. Michael Steer, Microwave and RF Design: A Systems Approach, SciTech Publishing Inc., 2010.
3. Frank Gustrau, RF and Microwave Engineering: Fundamentals of Wireless Communications, Wiley, 2012.
4. CrupiRaffo, Microwave Wireless Communications from Transistor to System Level, Elsevier Science, U.S.A., 2016.
5. Ulrich L. Rohde, RF/Microwave Circuit Design for Wireless Applications, (2e), John Wiley and Sons U.S.A., 2013.
6. Gabriele Manganaro, Advances in Analog and RF IC Design for Wireless Communication Systems, Elsevier Science, U.S.A., 2013.

AAE 5030 SATELLITE COMMUNICATION SYSTEM [3 1 0 4]

Introduction, satellite communication, overview. Orbital mechanics and launchers. Satellites: satellite subsystems, AOCS, TTC&M, power system, antennas, communication subsystem, equipment reliability and space qualification. Satellite Link Design: Transmission theory, system noise temperature, Uplink and Downlink design, Design for specified C/N, System design examples, Modulation and Multiplexing technique for satellite link: Frequency modulation, Analog FM transmission, Digital transmission, Digital modulation and demodulation, Multiple access, VSAT Systems, LEO, MEO and Non-Geostationary/ Geostationary satellites-design, GAGAN/IRNSS, Application of satellite

References:

1. Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communication, (2e), John Wiley and Sons, 2003.
2. Louis J. Ippolito Jr., Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance, 2nd Edition, Wiley, 2017.
3. Dennis Roddy, Satellite Communications, (4e), McGraw-Hill International, 2006.
4. Ilcev, StojceDimov, Global Mobile Satellite Communications Applications: For Maritime, Land and Aeronautical Applications, Volume 2, Springer International Publishing, 2018.
5. Andrew Barron, Amsats and Hamsats: Amateur Radio and other Small Satellites, Amazon Digital Services LLC, 2018.
6. Gerard Maral, Michel Bousquet, Zhili Sun, Satellite Communications Systems: Systems, Techniques and Technology, (5e), Wiley, 2010.

AAE 5031 SMART SENSORS DEVELOPMENT AND APPLICATION [3 1 0 4]

Introduction, Sensing and Sensor Fundamentals, Sensor Characteristics, Physical Principles of Sensing, Data Acquisition, Key Sensor Technology Components: Hardware and Software Overview, Optical Components of Sensors, Sensor Materials and Technologies, Interface Electronic Circuits, Occupancy and Motion Detectors, Position, Displacement, and Level, Velocity and Acceleration, Force, Strain, and Tactile Sensors, Sensor Deployments: Smart Sensor Systems for Aerospace Applications: , Full-Field Range Imaging System for Mobile Robotic Applications, Nano-Biosensor Development for Biomedical and Environmental Measurements, Sensor Deployments for Home and Community Settings, Body-Worn, Ambient, and Consumer Sensing for Health Applications, Wellness, Fitness, and Lifestyle Sensing Applications, Environmental Monitoring for Health and Wellness, Summary and Future Trends.

References:

1. Jacob Fraden, Handbook of Modern Sensors Physics, Designs, and Applications, Fourth Edition, Springer New York, 2010.
2. Michael J. Mc Grath Cliodhna NiScanaill, Sensor Technologies: Healthcare, Wellness, and Environmental Applications, Open Access, Springer Link, Apress, Berkeley, CA, 2013.
3. Subhas Chandra Mukhopadhyay, Aimé Lay-Ekuakille, and Anton Fuchs (Eds.), New Developments and Applications in Sensing Technology, Springer-Verlag Berlin Heidelberg, 2011.
4. Sergey Y. YurishMaria Teresa S. R. Gomes, Smart Sensors and MEMS, NATO Science Series book series (NAII, volume 181), Springer, Dordrecht, 2004.
5. Martin Liggins II, David Hall, James Llinas, Handbook of Multisensor Data Fusion: Theory and Practice, Second Edition, CRC Press, 2008.
6. David C. Swanson, Signal Processing for Intelligent Sensor Systems with MATLAB, 2nd Edition, CRC Press, 2011.

AAE 5032 SOFT COMPUTING SYSTEMS [3 1 0 4]

Soft Computing: Introduction to Intelligent Soft Computing: Introduction, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative

Memory, Adaptive Resonance Theory, Applications. Fundamentals of Neural Network: Introduction, Model of Artificial Neuron, Architectures, Learning Methods, Taxonomy of NN Systems, Adaptive Resonance Theory: Recap - supervised, unsupervised, backprop algorithms; Competitive Learning; Fuzzy Set Theory: Introduction, Fuzzy set: Membership, Operations, Properties; Fuzzy Relations. Fuzzy Systems, Fundamentals of Genetic Algorithms: Introduction, Encoding, Operators of Genetic Algorithm, Basic Genetic Algorithm, evolutionary programming. Hybrid Systems, Soft computing application in aerospace: Case study

References:

1. Tripathy B.K., Anuradha J., Soft Computing Advances and Applications, 1st Edition, Cengage Learning India Private Limited, 2015.
2. Sushil Kumar Singh, Soft Computing: Neural Networks, Fuzzy Logic and Genetic Algorithms, Galgotia, 2012.
3. Antonio Di Nola, Soft Computing: A Fusion of Foundations, Methodologies and Applications, Springer Berlin Heidelberg, 2018, ISSN: 1432-7643 (Print) 1433-7479 (Online).
4. Padhy N. P., S.P. Simon, Soft Computing: With MATLAB Programming, OUP India, Oxford Higher Education, 2015.
5. Valluru B. Rao, C++ Neural Networks and Fuzzy Logic, MTBooks, IDG Books Worldwide, Inc. ISBN: 1558515526, 1995.
6. Davis E. Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989.

AAE 5033 SYSTEM MODELING AND SIMULATION [3 1 0 4]

What are systems, Requirements writing for a System, Modelling of Flight Dynamics, Mathematical Concepts in Modeling, Frames and Coordinate, Kinematics of Translation and Rotation, simple ballistic trajectories to controlled and guided flight.Simulation of Aerospace Vehicles, Degrees-of-Freedom Simulation, Real-Time Applications, Familiarization with the CADAC FORTRAN and C++ simulations, Aerospace Simulations in C++, Aerospace Simulations in FORTRAN, Foundation of Tensor Flight Dynamics, CADAC++ Architecture, What is SysML, how and why to deploy MBSE, systems and model-based systems engineering, Systems Modeling Language, practical examples of MBSE methodologies to understand their application to specifying and designing a system, Architecting Spacecraft with SysML.

References:

1. Peter H. Zipfel, Modeling and Simulation of Aerospace Vehicle Dynamics, AIAA Education Series, (3e), American Institute of Aeronautics & Astronautics, 2014.
2. Dr. Peter H Zipfel, Fundamentals of Six Degrees of Freedom Aerospace Simulation and Analysis in FORTRAN and C++, Library of Flight, Cdr edition, American Institute of Aeronautics & Astronautics, 2004.
3. Brian L. Stevens, Frank L. Lewis, Eric N. Johnson, Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, (3e), John Wiley & Sons, 2016.
4. Dr. Peter H Zipfel, Modeling INS/GPS/Star-Tracker in 6 DoF: Simulating N&G&C of a Three-Stage Rocket Booster in CADAC++, 1 edition, CreateSpace Independent Publishing Platform, 2015.
5. Giuseppe Petrone, Giuliano Cammarata, Modelling and Simulation, IntechOpen, 2008.
6. George Koelsch, Requirements Writing for System Engineering, APress, 2016.

AAE 5034 VIRTUAL REALITY AND 3D IMAGING FOR MILITARY SIMULATION [3 1 0 4]

Introduction and Background, Virtual Reality, History, An Overview of Various Realities, Immerson, Presence, and Reality Trade-Offs, The Basics: Design Guidelines, Objective and Subjective Reality, Perceptual Models and Processes, Perceptual Modalities, Perception of Space and Time, Perceptual Stability, Attention, and Action, Perception, Adverse Health Effects: Transitioning to VR Content Creation, Content Creation: Design Guidelines, Interaction, Human-Centered Interaction, VR Interaction Concepts, Input Devices, Interaction Patterns and Techniques, Interaction: Design Guidelines, Iterative Design, Philosophy of Iterative Design, Iterative Design: Design Guidelines, The Future Starts Now, The Present and Future State of VR, Military application: Introduction, The Real and The Virtual, The Military Applications, Human Computer Interaction, Human Performance Metrics, The Capability of Virtual Reality to Meet Military Requirements, virtual Reality and Technologies for Combat Simulation, Virtual reality and its military utility, Military Simulation Systems.

References:

1. Jason Jerald, The VR Book: Human-Centered Design for Virtual Reality, Association for Computing Machinery and Morgan & Claypool New York, NY, USA, 2016.
2. Steven M. LaValle, Virtual Reality, Cambridge University Press, 2007.
3. Celine Tricart, Virtual Reality Filmmaking: Techniques & Best Practices for VR Filmmakers, Routledge, 2017.
4. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability), Addison-Wesley Professional, 2016.
5. Roger Dean Smith, Military Simulation & Serious Games: Where We Came from and Where We Are Going, Modelbenders LLC, 2009.
6. Neyland D, Virtual Combat: A Guide to Distributed Interactive Simulation, Satckpole Books, 1997.

OPEN ELECTIVES

AAE 5051 ANTENNA DESIGN, SIMULATION AND PLACEMENT FOR AEROSPACE [3 0 0 3]

Fundamentals of Antenna: Basic antenna radiation mechanism (single & double wire), Basic Antenna and Propagation Theory, Antennas and Applications: Structural details, dimensions, radiation pattern, specifications, features and applications of following Antennas: planer antennas, V- Antenna, Helical, Horn, Slot, Microstrip, Antennas with parabolic reflectors, Antennas Placement/Used on Aircraft, Computer Modelling Techniques, Radar Cross Section (RCS): Introduction of RCS, Need of RCS Measurements, RCS Design, Stealth technology and radar absorbing materials (RAM). Aircraft antenna design and analysis using software.

References

1. Balanis C. A., Antenna Theory - Analysis and Design, (4e), John Wiley, 2016.
2. Mathew N O Sadiku, Elements of Electromagnetics, (3e), Oxford University Press, 2001.
3. Thereza Macnamara, Introduction to Antenna Placement and Installation, Wiley, 2010.
4. John D Kraus, Ronald J Marhefka, Ahmad S Khan, Antennas for All Applications, (3e), The McGraw Hill Companies, 2008.
5. John D Kraus, Antenna & Wave Propagation, (4e), McGraw Hill, 2010.

6. Lo, Y.T., Lee, S. W., Antenna Handbook Theory, Applications, and Design, Springer US, 1988.

AAE 5052 UNMANNED AIRCRAFT SYSTEM [3 0 0 3]

Introduction to Unmanned Aircraft Systems (UAS) and Applications of UAS, Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects, Payload Types Control and Stability, Sensors and Autonomy, Navigation, Launch and Recovery, Control Stations- Control Station Composition, System Architecture, Support Equipment, Transportation, EMC/EMI of UAS. Introduction to System Development and Certification, UAV System Deployment, Defence Application-Navy Role, Army Role, Air force Role, Civilian, Paramilitary and Commercial Roles, Prospects and Challenges and Evolution. Economic and Business, Education and Research, Miscellaneous Missions, Special Topics

References:

1. Reg Austin, Unmanned Aircraft Systems UAVs Design, Development and Deployment, First Edition, A John Wiley and Sons, Ltd., 2010.
2. Jay Gundlach, Designing Unmanned Aircraft Systems: A Comprehensive Approach, (2e), AIAA Education Series, 2014.
3. Jay Gundlach, Civil and Commercial Unmanned Aircraft Systems, AIAA Education Series, 2016.
4. Dr David C. Ison, Small Unmanned Aircraft Systems Guide: Exploring Designs, Operations, Regulations, and Economics, Aviation Supplies & Academics Inc, 2017.
5. Douglas M. Marshall et al., Introduction to Unmanned Aircraft Systems, Second edition Taylor & Francis, 2016.
6. F. B. da Silva S.D. Scott M.L. Cummings, Design Methodology for Unmanned Aerial Vehicle (UAV) Team Coordination, MIT Department of Aeronautics and Astronautics, Cambridge, MA 0213, 2007.

AAE 5053 EMBEDDED SYSTEMS: SOFTWARE SAFETY AND SECURITY OF EMBEDDED SYSTEM [3 0 0 3]

Introduction of Embedded System, Embedded processor, Memory system, peripherals, Interfacing, Software Development based on ARM Processor etc: Keil Embedded development tools/ μVision, ARM, M-Cortex, Effective software development for aerospace safety and critical application, software development and testing, requirement analysis, SDLC & Fundamentals of Software Testing /Embedded System, Introduction to Coding Standards i.e. CERT C and MISRA C:2012, Top 10 Secure Coding Best Practices, Introduction to Functional Safety ISO 26262:2011 for Automotive, Introduction to Process Standard DO-178C for Avionics, Lab Session 1 (Static Analysis, SW Quality & Secure Coding Standards Compliance), Lab Session 2 (Structural Code Coverage), Lab Session 3 (Unit Testing, Target based Testing).

References:

1. Lee E. A. and Seshia S. A. , Introduction to Embedded Systems - A Cyber-Physical Systems Approach, (2e), MIT Press, 2017.
2. Kai Qian, David den Haring and Li Cao, Embedded Software Development with C, Springer Science and Business Media, LLC, 2009.
3. Michael Barr, Anthony Massa, Programming Embedded Systems, Second Edition with C and GNU Development Tools (2e), O'Reilly Media, 2009.
4. Renu Rajani, Pradeep Oak, Software Testing Effective Methods Tools & Techniques, Tata Mcgraw Hill Publishing Co Ltd, 2017.
5. MISRA C:2012 Standard.
6. SEI CERT C Secure Coding Standard.

Department of Biomedical Engineering

Biomedical Engineering is a fascinating multidisciplinary field in which the principles of engineering are applied to solving problems in medicine, & gaining a deeper insight into life-sciences, towards providing an overall enhancement to health care. The Biomedical Engineering program was started at the MIT in 1989 with a P. G Program (M. Tech.), and subsequently a U.G. program (B. Tech.) was started in 1992. The proximity of the reputed Kasturba Medical College under the same umbrella of MAHE offers a unique platform for training students in several fields, and renders the Biomedical Engineering program a very special one. Currently, the Department provides a variety of modern facilities to help the students acquire an in-depth technical knowledge in various topics in the field of Biomedical Engineering. The department encourages research activities and a Research Lab including a physiological signal acquisition lab are provided for the purpose. Areas of interest of the Faculty at the department include: Medical Imaging, Image Processing, and Physiological Signal Processing, Biomedical Instrumentation, Medical Devices, Nanotechnology and Biomaterials. Since 1998, the Headquarters of the Biomedical Engineering Society of India (BMESI) is at the Dept. of Biomedical Engineering.

Programs offered

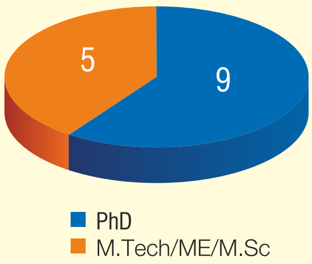
Under Graduate Program
- B.Tech in Biomedical Engineering (1992)

Post Graduate Program
- M.Tech in Biomedical Engineering (1989)

PhD

Faculty Strength

Qualification-wise



Cadre-wise

DEPARTMENT OF BIOMEDICAL ENGINEERING, MIT Manipal

M.Tech. BIOMEDICAL ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5151	Probability, Random Variables and Stochastic Processes	4	0	0	4	BME 5251	Basic Clinical Sciences	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	BME 5252	Medical Image Processing	4	0	0	4
	BME 5151	Advanced Biomedical Signal Processing Analysis and Modeling	4	0	0	4	BME ****	Elective I	4	0	0	4
	BME 5152	Biomechanics and Biodynamics	4	0	0	4	BME ****	Elective II	4	0	0	4
	BME 5153	Human Anatomy and Physiology	4	0	0	4	BME ****	Elective III	4	0	0	4
	BME 5154	Biomedical Instrumentation	4	0	0	4	*** ****	Open Elective	3	0	0	3
	BME 5161	Biomedical Instrumentation Lab	0	0	6	2	BME 5261	Biomechanics Lab	0	0	3	1
	BME 5162	Biomedical Signal Processing Lab	0	0	3	1	BME 5262	Medical Image Processing Lab	0	0	3	1
		Total	**21**	**0**	**12**	**25**		**Total**	**23**	**0**	**6**	**25**
II	THIRD AND FOURTH SEMESTER											
	BME 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
BME 5001	Biomaterials and Artificial Organs	BME 5006	Machine Learning
BME 5002	Cell Culture Techniques and Stem Cell Biology	BME 5007	Pattern Recognition
BME 5003	Data Communication and Networking in Healthcare Applications	BME 5008	Performance Modelling of Systems
BME 5004	Embedded Systems	BME 5009	Tissue Engineering
BME 5005	Experimental Techniques in Biomedical Research		

OPEN ELECTIVES			
BME 5051	Physiological Control Systems		

SEMESTER I

MAT 5151 PROBABILITY RANDOM VARIABLE AND STOCHASTIC PROCESSES [4 0 0 4]

Random Sampling, Sampling distributions, Parameter Estimation and Hypothesis Testing, Regression, Correlation and Analysis of Variance - Examples. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapmen Kolmogrov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes: assumptions and derivations, related distributions, birth and death processes. Queuing System, general concepts, Model M/M/1 and M/M/S, steady state behavior, transient behaviour.

Reference Books*:*

1. Hogg & Craig (1975), "Introduction to Mathematical Statistics", 4th Edn., MacMillan,
2. J. Medhi, "Stochastic Processes".
3. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes*,* McGraw Hill, 2002.
4. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles*,* McGraw Hill International Edition, 2001, Singapore.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

BME 5151 ADVANCED BIOMEDICAL SIGNAL PROCESSING ANALYSIS AND MODELING [4 0 0 4]

Time domain and frequency domain Filtering techniques for Removal of artifacts, Event Detection in Biomedical signals, Cross-Correlation and Coherence Analysis, Frequency-domain Analysis for Spectral Estimation. Short Time Fourier Transform analysis and Wavelet Transform analysis, Multichannel Signals Analysis, Principal Component and Independent Component Analysis, Regressive and Stochastic Modeling techniques for Biomedical systems.

References:

1. Proakis J G and Manolakis D G, Digital Signal Processing: Principles, Algorithms, and Applications, 3rd edition, Prentice Hall, 2002.
2. Rangaraj M Rangayyan, "Biomedical Signal Analysis - A case study", John Wiley and Sons, Singapore, 2002.
3. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley student edition, 2009.
4. Cohen, L. Time-Frequency Analysis: Theory and Applications. 1st edition, Prentice Hall, 1994.
5. Hlawatsch, F and F. Auger. Time Frequency Analysis: Concepts and Methods. 1 edition, Wiley-ISTE, 2008.

BME 5152 BIOMECHANICS AND BIODYNAMICS [4 0 0 4]

Anatomical movement descriptors, biomechanical principles of human movement, skeletal considerations for movement, muscular considerations for movement, fundamental concepts of gait, linear kinematics, angular kinematics, linear kinetics, angular kinetics, application of aerodynamics in sports application of hydrodynamics in aquatics.

References:

1. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Third Edition, 2008, Philadelphia.
2. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement*,* Allyn and Bacon Publishers, Fourth Edition, 1995, USA.
3. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, Fifth Edition, 2006, Singapore.

BME 5153 HUMAN ANATOMY & PHYSIOLOGY [4 0 0 4]

PART - A ANATOMY

Skeletal System: Types of bone, classification, Structure of bone, Blood supply, Cartilage: Type, Structure in brief, Joints: Classification, Structure of synovial joint, Major joints of the body. Muscle tissue: Types, Structure of skeletal muscle, Types of muscles, Brain: Parts, Brain stem, Ventricles, CSF, Meninges, Cranial nerves (names and functions only). Spinal cord: Gross features and structures, Spinal nerve, Nerve endings and receptors, Autonomic nervous system. Sensory system: Eye, Ear, Skin. Heart: Pericardium, Chambers, Blood supply Organs. Respiratory system: Parts, Trachea, Lungs. G I Tract: Parts, Stomach, Intestine, Liver, and Pancreas. Urinary system, Male and Female reproductive organs, and Endocrine glands.

References:

1. Sampath Madhyastha, "Manipal Manual of Anatomy", CBS Publishers & Distributors, Edition 3, 2016.

PART - B PHYSIOLOGY

Introductory lecture pertaining basic functional concept of the human body as a whole and contribution of the individual system. Hematology; Leverage system. Nerve action potential and its ionic basis. Body temperature regulation; Biophysical aspects of blood pressure (Bop) and its recording technique. Electrocardiograph and its gross normal features and alterations, Optics of the eye. Fundamental tonal analysis, determination of pitch, loudness and quality of sound. Sensorium -

general role of receptors as transducers, generation of potential in the receptors. Motor control of skilled voluntary movements: Mechanism of abnormal oscillatory movements Electroencephalogram and electrocorticogram.

References:

1. Charles E Tobin, "Manual of Human Dissection", McGraw Hill, Edition 4, 1961.
2. J Gibson, "Modern Physiology and Anatomy of Nurses", Black Well, 1981.
3. A J Vander, "J H Sherman, D S Luciano, Human Physiology", McGraw Hill, Edition 8, 2000.
4. Cyril A Keele, Eric Neil, Neil Norman Joels, "Samson's Wright's Applied Physiology", Oxford University Press, 1993.

BME 5154 BIOMEDICAL INSTRUMENTATION [4 0 0 4]

Study of Bio-electric signals & Electrodes, Transducers, Blood pressure & Blood flow measurements. Study of Diathermy, Haemodialyser, Lithotriptor, Pulse Oximetry: Introduction, other methods to determine oxygen saturation of blood, major parts of pulse oximetry, applications of pulse oximetry. Anesthesia machine, Ventilator, Infusion pump, Infant Incubator; Study of Surgical devices: ESU, LASER & Endoscope. Cardiac-assist devices: Heart lung machine, Pacemaker & Defibrillator. Study of Ultrasonography and Thermography, Introduction to X-ray imaging, Magnetic Resonance Imaging, Single-photon emission computed tomography and Positron Emission Tomography

Reference Books:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, 1980.
2. Leslie Cromwell, "Bio Medical Instrumentation", PHI, 1990.
3. Geddes and Baker, "Principles of Applied Bio-Medical Instrumentation", John Wiley, 1989.
4. J.G. Webster," Medical Instrumentation, Application and Design" Houghton Miffin Co. Boston.

BME 5161 BIOMEDICAL INSTRUMENTATION LAB [0 0 6 2]

Study of the characteristics of Capacitive pickup transducer, Inductive pickup transducer, pressure cell, Strain sensor, RTD transducer, Linear Variable Differential Transformer (LVDT), Hall effect transducer, LDR / Phototransistor and photodiode, load cell, thermocouple, DC serve motor control, voltage to frequency converter; Realization of a Pacemaker circuit and Instrumentation amplifier.

Demonstration: Study of Electrocardiograph and determining the cardiac vector; study of Audiometer and Air conduction thresholds testing; study of Blood Pressure meter, Defibrillator, Electrosurgical unit (ESU), Phonocardiograph and to visualize the heart sounds. Design and implementation of circuits with biomedical applications like QRS detector, Hearing aids, Digital thermometer etc.

References:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, 1980.
2. Leslie Cromwell, "Bio Medical Instrumentation", PHI, 1990.

BME 5162 BIOMEDICAL SIGNAL PROCESSING LAB [0 0 3 1]

Introduction to MATLAB. Generation of sequences: Unit sample, unit step, real/complex exponential, sinusoidal; LSI systems: Investigation of linearity & time-invariance, Computation of impulse response, Convolution, Stability; Computing and plotting the frequency response from the transfer function/unit-sample response; pole-zero plot from the transfer function. DFT: Illustration of circular shift of a sequence, circular time-shifting & circular convolution property, linear convolution via circular convolution; Computation of the DFT / FFT of a 1D signal. Implementation of FIR and IIR filters. Power spectrum estimation: Periodogram & Welch's method. ECG: QRS detection, extracting the RRI series and calculation of heart rate; the utility of Auto correlation & Cross correlation for template matching. ECG signal compression using Turning Point algorithm & DCT.

References:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Pearson Education India; 2nd Edition (2015).
2. Ronald W. Schafer, Alan V. Oppenheim, Discrete-Time Signal Processing, PEARSON 3rd Edition, 2014.

Rangaraj M Rangayyan, "Biomedical Signal Analysis - A case study", John Wiley and Sons,Singapore, 2002.

SEMESTER II

BME 5251 BASIC CLINICAL SCIENCES [4 0 0 4]

PART-A PHYSIOTHERAPY

Physiology of pain and pain modulation, Pain reliving Modalities-Role of TENS, Interferential current therapy, Pain reliving modalities-II: Superficial Heating modalities, Short wave diathermy, Ultra sound, Laser, EMG, nerve conduction studies, Bio feedback and other diagnostic currents, Gait and gait analysis systems. Fitness, Cardiac and pulmonary rehabilitation- analysis and training instrumentation including Ergometer, Treadmill Evaluation methods: Concept of MMT, Dynamometer, Isokinetic, Esthisiometer, Goniometer, Instrumentation for different type of exercise: CPM, Hydrotherapy, Suspension. Introduction to Joint biomechanics with example of Knee and Hip Joint Orthotics and prosthesis, Practical Demonstration

References:

1. Gardiner M. Deena "The Principles of Exercise Therapy", CBS Publishers & Distributors, 2007
2. Sheila Ed. Kitchen, Sarah Ed. Bazin "Clayton's Electrotherapy"10th edition, Bailliere Tindall, 1996
3. Susan B. O'Sullivan PT, EdD, Thomas J. Schmitz PT, PhD George Fulk PT, PhD F.A Davis, "Physical Rehabilitation", 6th Edition, F A Davis Company, 2014

PART-B SPEECH & HEARING

Audiometers, Middle ear analyzer, Evoked potentials, OAE, hearing aids, Cochlear implants, ALD, Hearing aid analyzer, Electro Glotto graphy, AAC, Introduction to speech assessment, DSP, Assessment of voice and fluency, Voice and fluency therapy assessment, Artificial larynx, Spirometry, Speech synthesis, Practical demonstration.

References:

1. Community based Rehabilitation, ISBNO 0-7020-1941-0, Saunders, London, 1997.
2. A Nenfeldt and A Albrigt, "Disability and Self- directed employment", 1998.
3. Keele Cyril A, Eric Neil, "Samson Wright's applied Physiology", oxford University Press, 1993.

PART - C ORTHOPAEDICS

Bioengineering aspects of fracture management: Structure of bone-gross, Microscopic biochemical fractures: Types, Mechanism of injury, Normal Healing of Fractures, Treatment of fractures: General principles, The concepts of load bearing, load sharing and stress shielding by implants, Piezo electricity and electrical stimulation for bone healing, Bioengineering aspects of joint diseases, Structure of joints: Fibrous, Cartilaginous, Synovial, Lubrication of joints and the functions of articular cartilage, Degeneration of cartilage, Degenerative arthritis and Rheumatoid arthritis, Joint replacement, hip, knee, shoulder, small joints. Biomaterials: Gait analysis, Orthotics, Principles of tendon transfer, Bioengineering principles of amputation and prosthetics, Upper limb prosthesis, Lower limb prosthesis.

References:

1. Victor H Frankel and Margareta Nordin, “Basic Biomechanics of the skeletal system”. Lea and Febiger, 1980.
2. M. Dena Gardiner, “The principles of exercise therapy”, CBS press, Edition 4, 1985.

BME 5252 MEDICAL IMAGE PROCESSING [4 0 0 4]

Signals & systems in 1D & 2D; 2D DFT and its computation. Image perception the human vision system, psycho-visual experiments, monochrome vision model, temporal properties. Image compression the discrete cosine transform (DCT), properties, computation, practical compression algorithm. Image Enhancement: Point operations and Spatial filtering: linear filters & the median filter. Connected-component labeling. Medical Imaging: Imaging modalities; Computed tomography (CT): mathematical basis, the Radon transform & the central slice theorem; Image reconstruction from projections: The Direct Fourier Method, convolution back-projection (CBP), reconstruction from fan-beam projections; X-rays: utility, generation and detection; X-ray CT systems. Emission CT: principles, Positron emission tomography (PET); Magnetic resonance imaging: Principles of data-generation, resolving the tissues, resolving the spatial locations. Edge detection; Colour-image processing: Fundamentals, Colour Models, Biomedical Engineering Applications.

References:

1. R.C Gonzalez and R.E. Woods, Digital Image Processing, 2nd Ed., Pearson Education Inc., Eighth Indian Reprint, 2002.
2. Jae S. Lim, Two-dimensional Signal and Image Processing, Prentice-Hall, Englewood Cliffs, New Jersey, 1990.
3. A. K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 1989, Fourth Indian Reprint.
4. A.C. Kak and M. Slaney, Principles of Computerized Tomographic Imaging, SIAM's Classics in Applied Mathematics, Philadelphia, SIAM, 2001.
5. Kline Jacob, Handbook of Biomedical Engineering, Academic Press, 1988.

BME 5261 BIOMECHANICS LAB [0 0 3 1]

Modelling and Simulation using Opensim, Measuring Kinetic parameters using Force Plate, 2D motion data acquisition and analysis using Kinovea, Introduction to 3D motion analysis.

References:

1. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Third Edition, 2008, Philadelphia.
2. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement, Allyn and Bacon Publishers, Fourth Edition, 1995, USA.

BME 5262 MEDICAL IMAGE PROCESSING LAB [0 0 3 1]

Image Processing - Display and simple manipulations: flipping, rotation, and scaling; Decimation & interpolation; Effects of thresholding; Bit-plane mapping. Histogram of an image; Contrast enhancement: Application of manually specified transforms, Contrast Stretching; Computation of the 2D DFT, 2D FFT. Image Filtering - Spatial domain techniques: Neighborhood averaging

Median Filtering; Frequency-domain techniques: High pass and low pass filtering. Edge detection: Sobel, Prewitt & Robert's operators. Image Compression using DCT. The Radon Transform (RT): The RT of the Shepp-Logan Phantom; The inverse RT and image reconstruction from projections; Effects of the number of projections. Implementation of CBP algorithm, Hough transform & Geometric transformations.

References:

1. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, 2nd Edition, Tata McGraw-Hill Education 2010.
2. A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989, Fourth Indian Reprint.

SEMESTER III and IV

BME 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

BME 5001 BIOMATERIALS & ARTIFICIAL ORGANS [4 0 0 4]

A Brief discussion of: metallic biomaterials, Ceramic biomaterials, Polymeric biomaterials, Composite biomaterials. Soft tissue replacements, Hard tissue replacements, Bone repair and joint implants: Dental implants, Artificial Kidney: structure and function of the kidney, kidney disease, renal failure, treatment of renal failure, Renal transplantation, Liver Support systems: Morphology of the liver, liver functions, hepatic failure, liver support systems global replacement of liver function, hybrid replacement procedures. Artificial Pancreas: Structure and function of pancreas, endocrine pancreas and insulin secretion, Diabetics, Insulin, Insulin therapy, therapeutic options in diabetics, Insulin administration systems, Insulin production systems, outlook., Artificial Blood: Modern history of blood transfusion and blood substitutes, blood components and characteristics, blood substitutes and Hem dilution, crystalloid solutions as volume expanders, Artificial skin and dermal equivalents: A vital function of skin, current treatment of massive skin loss.

References:

1. Joseph D Bronzino, *"The Biomedical Engineering hand book",* CRC Press Edition 2, 2000.
2. Park JoonBu, "Biomaterials Science and Engineering", Plenum Press, 1990.
3. Buddy D Ratner & Allen S. Hoftman "Biomaterials Science an introduction to Materials in Medicine*" Academic Press, 1996.*

BME 5002 CELL CULTURE TECHNIQUES AND STEM CELL BIOLOGY [4 0 0 4]

The goal of this course is to impart students with the knowledge of cell culture techniques and provide insights into stem cell biology. Students taking this course would get a detailed understanding of techniques and protocols related to animal cell cultures. Apart from cell culture techniques, students also learn the fundamental of developmental and stem cell biology. This course will be helpful for students who want to pursue a career in basic biomedical research especially in areas like tissue engineering, biomaterials, Nano biotechnology and regenerative medicine

References

1. The culture of animal cells: A manual of basic technique and specialised applications (Seventh edition). Ian Freshney Wiley, ISBN-13: 978-0879696733.
2. Essentials of Stem Cell Biology (Third Edition). Robert Lanza and Anthony Atala, Elsevier, ISBN: 978-0-12-409503-8.
3. Stem Cell Biology, Daniel R. Marshak, Richard Lavenham Gardner, David Gottlieb, Cold spring harbour laboratory press. ISBN-13: 978-0471739913.

BME 5003 DATA COMMUNICATION AND NETWORKING IN HEALTH CARE APPLICATIONS [4 0 0 4]

Data communication model, types of network and goals, Internet, Network hardware and software, design issues, ISO-OSI and TCP/IP Protocol Architecture, Data Communication Devices, communication media, data transmission, multiplexing, switching and switching techniques, Digital data communication techniques: Error detection, error correction, Data link protocols, Medium access sublayer: LAN, MAN, WAN, channel allocation, multiple access protocol, fiber optic networks, satellite networks and wireless LAN, Network layer: routing algorithms, congestion control algorithm, internetworking, internet control protocols, Internet addresses, Classes of IP addresses, TCP/IP networks, ARP and RARP, Transport layer: the transport services, transport protocols (TCP and UDP), connection management (Handshaking), Application Layer, and Network Security, healthcare applications: Health services and health information through internet / mobile (body sensor networks, Telemedicine, Tele-health/ e-health, Home healthcare/ mobile health care and mentoring).

References:

1. William Stallings, "Data and Computer communication", Prentice Hall of India, 8th Edition, 2010.
2. Tanenbaum Andrew S, "Computer Networks", Prentice Hall of India, 3rd edition, 2005.
3. Douglas E Comer, "Internetworking with TCP/IP Vol I: Principles, Protocols and Architecture", III Ed. Prentice Hall of India, 1997.
4. Behrouz. A.Forouzen, "Data Communications and Networking", 3rd Edition, Tata McGraw HILL, 2004.

BME 5004 EMBEDDED SYSTEMS [4 0 0 4]

Introduction to Embedded systems, processor and memory organization, Devices and buses for device networks, Device drivers and interrupts servicing mechanisms. Programming concepts, and embedded programming in C. Real Time Operating systems, and Serial and Parallel Buses. PIC Architecture and Instruction set, MPASM assembler and its usage, Analog-to-Digital conversion, UART. Medical Embedded systems.

References:

1. Raj Kamal, "Embedded systems Architecture, programming and Design" TaTa McGraw Hill, 4th Reprint 2008.
2. Frank Vahid and Tony Givargis, "Embedded system Design a Unified Hardware/Software Introduction" Wiley India Pvt. Ltd.
3. Tim Wilmshurst, "An Introduction to the design of Small Scale Embedded Systems" Palgrave, NewYork 2003.
4. John B. Peatman, "Design with PIC Microcontrollers", first Edition, Pearson Education.

BME 5005 EXPERIMENTAL TECHNIQUES IN BIOMEDICAL RESEARCH [4 0 0 4]

The objective of this course is to impart knowledge of various experimental techniques and methodologies related to the field of biomedical research. The course is intended for students who are interested in pursuing biomedical research associated with areas of biomaterials, drug delivery, tissue engineering, material sciences and bio nanotechnology. The course structure is divided into three major parts, of which the first and second part deals with experimental techniques employed in the characterisation of materials and biological entities. The final section of this course is meant to address questions such as how experiments are designed and to analyse experimental data critically. At the end of the course, students who completed the course would be confident in interpreting experimental data that is published in biomedical journals.

Reference:

1. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson, John Walker, 7th edition. Cambridge University Press, ISBN 978-0-521-51635-8.
2. A Guide to Methods in the Biomedical Sciences. Ronald B. Corley, Springer.

BME 5006 MACHINE LEARNING [4 0 0 4]

Basics of machine Learning, principle and Applications in healthcare, machine Learning Foundations, Learning methods: Basic concepts in machine learning and an example. Design cycle for developing machine learning application. Perspectives and issues in machine learning. Linear models and regression models, Discriminate Functions, Single layer neural network, linear reparability, general gradient descent, perception learning algorithm, multi-layer perception: back propagation learning, Support Vector Machines (SVM), SVM for classification. Introduction to Deep learning networks. Clustering, Independent components analysis, Decision Tree learning, Reinforcement learning control, evolutionary optimization techniques, statistical machine learning, machine learning in Healthcare applications.

References:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education, 2013.
2. Richard o. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons Inc., 2001.

3. Ethem Alpaydin, “Introduction to Machine Learning”, Prentice Hall of India, 2005.
4. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer; 2nd, 2011.
5. Saeid Sanei, and Jonathon A Chambers, “EEG Signal Processing”, John Wiley and Sons, 2007.

BME 5007 PATTERN RECOGNITION [4 0 0 4]

Machine perception, Pattern recognition (PR) system, Statistical decision theory, patterns and feature extractions, Applications of Pattern Recognition, The Design Cycle, Training and learning in PR system, Pattern recognition approaches, Statistical decision making: Bayes theorem, multiple features, conditionally independent features, Decision boundaries, Unequal costs of error, Estimation of error rates, leaving one-out technique, Characteristic curves, problems, Syntactic Pattern Recognition: Syntactic pattern recognition overview, quantifying structure in pattern description and recognition, Grammar based approach and applications, Supervised Learning (Training) using parametric and non-parametric approaches, Histograms, nearest neighbor classification techniques, Unsupervised learning and clustering, Artificial Neural Networks: Introduction, Nets without and with Hidden layers, Hebbs net, Perceptron algorithm, Back propagation algorithm and Applications.

References:

1. Richchard O Duda, Peter E. Hart, David G.Strok, “Pattern Classification”, Wiley edition, 2001.
2. Earl Gose, Richard, Johnson baugh and Steve Jost, “Pattern recognition and Image analysis”, Prentice Hall, 2002.
3. Schalkoff Robert J, “Pattern recognition”, John Wiley,1992.
4. E.S.Gelsema and L.N. Kanal, "Pattern Recognition and Artificial Intelligence", Elseveir Science, 1998

BME 5008 PERFORMANCE MODELLING OF SYSTEMS [4 0 0 4]

This course covers the topics related to input-output configuration of measuring systems, general concepts of transfer functions, instruments classification, set theory concept- Functions, relations, combinatorics, theory of counting, brief theory of bags, Graphs and algorithms-concepts of nodes and arcs, trees, Prime's algorithm, binary trees, planar graphs, Euler's theorem, Performance models, Petrinet graph, Reachability problems, S-nets and Introduction to Petrinet and S Net models.

References:

1. E. O. Doeblin, “Measurement systems: Application and Design”, McGraw Hill Publishers.
2. Oliver and Cage, “Electronic measurements and instrumentation”, McGraw Hill International Editions.

BME 5009 TISSUE ENGINEERING [4 0 0 4]

Introduction: Basic definition, Structural and organization of tissues: epithelial, connective tissues; Sterilization process: Introduction, different sterilization methods: physical, chemicals; applications in terms of tissue engineering, Morphogenesis, Tissue homeostasis, Cellular signaling: introduction, cellular signaling in skin, bone cartilage biology; understanding and implementing principles of cell signaling in tissue engineering; Stem cell: introduction, types, embryonic and adult stem cells, recent advances and future perspective, Cell culture, cell source, cell types, various aspects; cell-cell interaction, Molecular biology aspect, Scaffold: polymer, natural polymer for tissue engineering, degradable materials, various type of scaffold, cell –matrix interaction, micro and nanofabrication techniques in scaffold fabrication and their importance in tissue regeneration, Engineering tissues for replacing bone, cartilage

Reference Books:

1. Satya Prakash, D.S. Tim, Stem cell bioengineering and tissue engineering microenvironment, World Scientific, 2012 ISBN: 139782837882
2. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engineering, Academic press, 1998
3. Frontiers in tissue engineering C.W. Patrick Jr., A. G. Mikos, L.V. Mcintire, Pergamon, Elsevier, 1998 ISBN: 008042689 1
4. B. O Palsson, Sangeeta N. Bhatia, Tissue Engineering, Edition 1, 2004 Pearson, New Jersey, USA, ISBN 0-13-041696-7
5. S. Li et al, stem cell and Tissue Engineering, World Scientific, 2011, ISBN 13 978-981-4317-05-4.

OPEN ELECTIVE

BME 5051 PHYSIOLOGICAL CONTROL SYSTEMS [3 0 0 3]

Introduction to Technological Control System, Transfer functions, Mathematical Approaches, System Stability, Feedback Concept and Stability Analysis. Introduction to Biological Control System, similarities and differences, Transfer of substances between compartments, Biological receptors, characteristics, Regulation of acid-base balance, Endocrine Control, Regulation of Extra Cellular Water and Electrolyte. Introduction to Various Process Controls like Cardiac Rate, Blood Pressure, Respiratory Rate and Blood Glucose Regulation. Modelling of Human Thermal Regulatory System, Parameters Involved, Control System Models etc. Biochemistry of Digestion. Type of Heat Loss from the Body, Model of Heat Transfer between Subsystems of Human Body like Skin, Core, etc, Respiratory control system, Modelling of O2 Uptake, Mass Balancing by Lungs, Gas Transport Mechanism of Lungs, O2 and CO2 Transport in Blood and Tissue. Introduction to Eye Tracking and Control. Cardio Vascular Control system, pupil control system, MATLAB applications in control systems.

References:

1. H. T. Milhorn, “The Applications of Control Theory to Physiological System”, W.B. Saunders, 1966.
2. J. H... Milsum, Biological Control System Analysis, McGraw Hill, 1966.
3. B. C. Kuo, Automatic Control System, 9th edition, Prentice Hall, 2009.

Department of Biotechnology

The Department of Biotechnology came into existence with the admission of students for the B.Tech. program in Biotechnology, from the year 2005. The department also offers M.Tech in Industrial Biotechnology and full time Ph.D. courses. The objective of the courses is to mold our students with all the technical skills needed for employment in the diverse areas of biotechnology, especially industry and research based careers. The curricula of the programs provide an equal weightage to the core principles of biological sciences, computational analysis and process engineering principlesapplied to biotechnology. Flexibility in the course curriculum is offered by means of providing minor specialization in the areas of environmental and pharmaceutical biotechnology. Being a multidisciplinary campus, the students have the advantage of conducting research in frontier areas of core life sciences, pharmaceutical sciences and medical biotechnology in the constituent institutions of MAHE.

Equipped with a total of thirteen laboratories, the department offers hands-on experience in most aspects of biotechnology. This course has been designed to provide the students with both theoretical knowledge and practical skills to keep pace with latest developments and to cater to the needs of industrial biotechnology sector. As regards the faculty composition, nearly 85% of our faculty members have a Ph.D. degree and the rest are actively pursuing the same. The core competencies of our faculty lie in the fields of environmental biotechnology, bioinformatics, drug delivery, biopolymers, biofuels, animal cell and plant tissue culture.

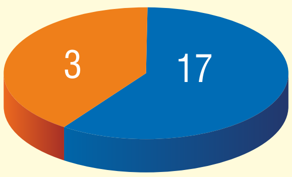
Programs offered

Under Graduate Program
- B.Tech in Biotechnology (2005)

Post Graduate Programs
- M.Tech in Industrial Biotechnology (2009)

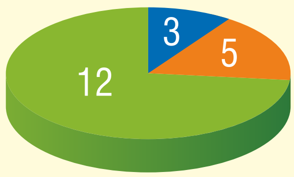
Faculty Strength

Qualification-wise

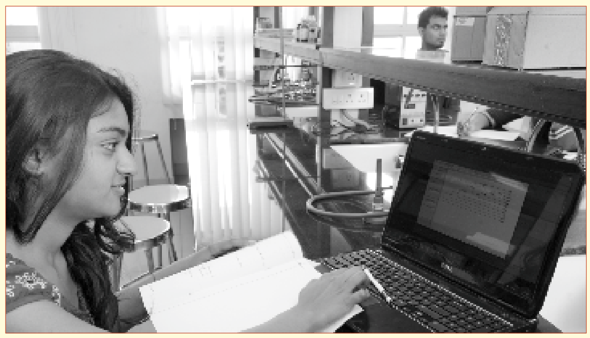


- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors



DEPARTMENT OF BIOTECHNOLOGY, MIT Manipal

M.Tech. INDUSTRIAL BIOTECHNOLOGY

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5158	Mathematical and Numerical Techniques in Chemical and Biological Engineering	3	1	0	4	BIO 5251	Bioprocess Modeling Analysis and Simulation	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	BIO 5254	Bioreactor Design and Analysis	3	1	0	4
	BIO 5151	Advanced Bioprocess Engineering	3	1	0	4	BIO ****	Elective I	4	0	0	4
	BIO 5152	Advanced Bioseparation Processes	3	1	0	4	BIO ****	Elective II	4	0	0	4
	BIO 5153	Molecular Biology And R-DNA Technology	3	1	0	4	BIO ****	Elective III	4	0	0	4
	BIO 5154	Transport Phenomena in Bioprocess Engineering	3	1	0	4	*** ****	Open Elective	3	0	0	3
	BIO 5161	Bioprocess Engineering Lab	0	0	6	2	BIO 5265	Biomolecular Data Analytics Lab	0	0	3	1
	BIO 5162	Tissue Culture and Separations Lab	0	0	3	1	BIO 5266	Modeling, Simulation and Control Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**21**	**2**	**6**	**25**
II	THIRD AND FOURTH SEMESTER											
	BIO 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
BIO 5001	Animal and Plant Biotechnology	BIO 5007	Immunotechnology
BIO 5002	Biomolecular Data Analytics	BIO 5008	IPR Issues in Biotechnology and Biosafety
BIO 5003	Biopolymer Technology	BIO 5009	Pharmaceutical Biotechnology
BIO 5004	Design and Development of Biological Treatment Processes	BIO 5010	Solid Waste Management
BIO 5005	Environmental Biotechnology	BIO 5011	Statistical Design and Analysis of Experiments in Biotechnology
		BIO 5012	Systems Biology

OPEN ELECTIVES			
BIO 5051	Bionanotechnology	BIO 5052	Introduction to Biofuels and Biopolymers

SEMESTER I

MAT 5158 MATHEMATICAL AND NUMERICAL TECHNIQUES INCHEMICAL AND BIOLOGICAL ENGINEERING [3 1 0 4]

Solution of system of linear equations by direct and iteration methods., Eigen values and Eigen vectors of Matrices by iterative methods, Rayleigh's Power method, Numerical Integration by composite integration methods, Regression-Linear, Polynomial, multiple linear, Non-linear regression, Orthogonal polynomials and functions.Algebraic and transcendental equations-Iterative methods. Numerical solution of differential equations-Initial value problems and boundary value problems- Single and multistep methods. Multivariate non-linear optimization without constraints

References:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for scientific and engineering computation, New age international (P) Limited, Publishers.
2. SanthoshK.Gupta, Numerical methods for Engineer, Wiley Eastern Ltd, New Delhi.

HUM 5151 RESEARCH METHODOLOGIES AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology; Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation; Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem; Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, Need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing; Sampling Methods: Introduction to various sampling methods and their applications; Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis; Thesis Writing and Journal Publication: Writing thesis, Writing journal and conference papers, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.

BIO 5151 ADVANCED BIOPROCESS ENGINEERING [3 1 0 4]

Structure, properties and classification of carbohydrates, lipids, proteins & nucleic acids; Prokaryotes & Eukaryotes; Bacterial Taxonomy, Microscopy,; Isolation, Preservation and Improvement of Industrial Micro-Organisms; Medium requirement; Sterilization - batch and continuous, filter sterilization. Design of sterilization equipment;Classification of Enzymes; Mechanism of Enzyme Action; Determination of elementary step rate kinetics, patterns of substrate concentration dependence, modulation and regulation of enzyme activity; Phases of cell growth in batch cultures - transient growth kinetics, Simple unstructured kinetic models for microbial growth, Growth of filamentous organisms; Conditions affecting growth kinetics, substrate & product inhibition on cell growth & product formation; structured kinetic models, segregated kinetic models of growth; Material-Balance calculations, Stoichiometry of microbial growth & Product formation, Energy – Balance Calculations with and Without Reactions; A brief outline of processes for the production of some commercially important Organic acids, amino acids and alcohols, study of production processes for various classes of low molecular weight secondary metabolites: Antibiotics, quinones, aromatics, Vitamins and Steroid.

References:

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts (2e), Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Pauline M Doran, Bioprocess engineering principles (1e), Academic Press, 1995.

BIO 5152 ADVANCED BIOSEPARATION PROCESSES [3 1 0 4]

Role of Downstream Processing in Biotechnology; Economics and downstream processing, Cost cutting, Cell disruption; flocculation, sedimentation, centrifugation and filtration; Precipitation methods; Extraction: Batch, staged - cross current, co current, counter current, Differential, fractional, Aqueous two-phase, Reverse micelle extraction, supercritical fluid extraction, Design & configuration of membrane separation equipment; R.O., dialysis, electro dialysis, IEF; Adsorption isotherms, industrial adsorbents, adsorption equipments for batch and continuous operations, adsorption in fixed beds; Chromatography: Gel filtration, reversed-phase, hydrophobic interaction, ion-exchange, expanded bed adsorption, bio affinity and IMAC, supercritical fluid; Preparation of commercial enzymes: prolyl-t RNA synthetase; intracellular foreign proteins from recombinant *E.coli and* extracellular protease recovery, biosurfactants.

References:

1. Belter P.A, Cussler E and Wei Shan Hu, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience, 1988.
2. Asenjo and Juan A. Asenjo, Separation Processes in Biotechnology, CRC Press, 1990.

BIO 5153 MOLECULAR BIOLOGY & r-DNA TECHNOLOGY [3 1 0 4]

Forms of DNA & RNA, Organization of DNA; DNA Replication in Prokaryotes & Eukaryotes, Telomeric Replication; Replication of Viral DNA; Transcription in Prokaryotes & Eukaryotes, Post-transcriptional Modifications, Genetic Code, Wobble Hypothesis, Translation in Prokaryotes & Eukaryotes, Post-translational Modifications; Operons; DNA Repair, Mutations and Mutagenesis; Basics of rDNA Technology; Enzymes in Genetic Engineering; Nucleic Acid Hybridization, Probes & DNA Libraries; Re**s**triction Mapping, Adaptors & Linkers, PCR, RFLP, RAPD, DNA Sequencing; SNPs, VNTRs; Therapeutic proteins from Transgenic plants & animals, Gene Therapy; Recombinant DNA Vaccines; Resistance to Herbicides, virus, insect and pests, Stress tolerance; DNA fingerprinting, Directed mutagenesis, Antisense Technology.

Reference:

1. David Friefelder, Molecular Biology (2e), Jones and Bartlett Publishers Inc, 1987.
2. Benjamin Lewin, Genes VIII , Prentice Hall , 2004.

BIO 5154 TRANSPORT PHENOMENA IN BIOPROCESS ENGINEERING [3 1 0 4]

Introduction to Momentum, heat and mass transfer, Unified equation of momentum heat and mass transfer, Shell Momentum balances and velocity distributions in laminar flow -flow of a falling film, circular tube, flow through an annulus, flow of two adjacent immiscible fluids. The equations of change for isothermal systems, equation of motion and dimensional analysis. Heat conduction and convection in different systems using shell energy balance to find out temperature distribution. Diffusivity and the Mechanisms of Mass Transport, Diffusion through a stagnant gas film, homogeneous and heterogeneous chemical reaction, gas absorption and porous catalyst. Velocity distributions with more than one Independent variable, The equations of change for non-isothermal systems, Temperature distributions with more than one independent variable, Equations of change for multicomponent systems.

References:

1. *Arthur T. Johnson*, Biological Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems, John Wiley and Sons, 1998.
2. Blanch H.W and Douglas S. C, Biochemical Engineering, CRC Press, 1997.

BIO 5161 BIOPROCESS ENGINEERING LAB [0 0 6 2]

Pure culture techniques,SDS – PAGE of proteins, Microbial growth kinetics, Effect of substrate concentration on kinetics of invertase enzyme,Enzyme immobilization protocol by entrapment method in alginate gel,Deactivation kinetics of invertase enzyme,Studies on mass transfer effects on the performance of enzyme entrapped in alginate gel,Batch recycle immobilized packed bed bioreactor,Continuous flow immobilized enzyme packed bed bio reactor,Fluidized bed bioreactor (FBR) for enzyme kinetics,Batch heat sterilization and thermal death kinetics

BIO 5162 TISSUE CULTURE AND SEPARATIONS LAB [0 0 3 1]

Characterization of plant cell suspension cultures-cell growth, Cell count, heterogeneity and viability, Isolation, identification and quantification of secondary metabolite berberine from in vitro cultures and field grown plants, Isolation of RNA from Plants, Isolation of RNA from Plants, Organelle isolation and marker enzyme assay, Determining cell viability, Thawing of frozen cell line, Sub-culturing of cells, Ultra-filtration, Size Exclusion Chromatography, Partitioning of Protein

SEMESTER II

BIO 5251 BIOPROCESS MODELING, ANALYSIS & SIMULATION [3 1 0 4]

Perspective on modeling of physical, chemical & biological phenomena, uses and limitations of mathematical models; Examples involving algebraic, ordinary differential, difference, partial differential, integral & integro-differential equations; Probability theory, stochastic models parameter estimation model forms for parameter estimation. Parameter estimation using moments, design of experiments; Accuracy of parameter estimates. Design of experiments for model discrimination; Non linear systems; Plane analysis in classical bioreactor models; Nonlinear dynamics; Chaotic behavior, cob web diagrams, stability of fixed point solutions. Bifurcations behavior, Chaos; Lorenz equations; Population balance modeling, Budding of yeast population – Modeling of cells with dynamic morphology – Modeling for biological populations with correlation between life spans of siblings. Modeling of Industrial sterilization processes

References:

1. Wayne Bequette.B, Process dynamics modeling and analysis and simulation,. Prentice Hall Inc, 2004.
2. John H. Seinfeld and Leon Lapidus., Mathematical Methods in Chemical Engg., (Vol. 3), Process Modeling, Estimations and Identification. Prentice Hall, 1974.

BIO 5254 BIOREACTOR DESIGN AND ANALYSIS [3 1 0 4]

Mass transfer effects in heterogeneous reaction system; Chemostat with cell cultures; CSTR with immobilized enzymes, operation of CSTR in constant feed rate policy; Chemostats in series; Plug flow reactor; Performance equation with M-M kinetics, substrate & product inhibition kinetics, PFR for immobilized enzymes, Simulation for conversion; Fed–batch reactor; Stability analysis, Eigen values; Bioreactor control; Controllability matrix; Design of P-controller for Turbidostat & Nutristat operation; Biological waste water treatment with Feed forward control; Various industrial Bioreactors; aeration and oxygen mass transfer in bioreactor system, RTD, E, C ,F-curves, Micro & Macro fluid.

References:

1. Blanch H.W and Douglas S. Clark, *Biochemical Engineering,* CRC Press, 1997.
2. Michael L Shuler and Fikret Kargi, *Bioprocess Engineering: Basic Concepts*, Prentice-Hall of India Pvt Ltd, 2008.

BIO 5265 BIOMOLECULAR DATA ANALYTICS LAB [0 0 3 1]

Information retrieval from databases, Sequence alignment: Pairwise and Multiple sequences, Basics of PERL programming, Primer Design, Protein secondary structure prediction, Structure visualization & analysis, Protein modeling, analysis, and validation, Protein-ligand docking, Protein-protein docking, 3D-printing of biomolecules.

BIO 5266 MODELING, SIMULATION AND CONTROL LAB [0 0 3 1]

Representation of transfer functions and input-output models using Matlab commands, Response plots, stability analysis and design of proportional controller for bioreactor,Performance analysis of fed batch and chemostat reactors –solution for set of differential equations, Performance analysis of bioreactor using Matlab-use of phase plane analysis, Introduction to Simulink and building a dynamic model for fermentation process with Simulink, Design of chemostat using grapher (GUI interface), Flow control trainer, Temperature measurement and calibration of thermometers & first order systems, Non interacting & interacting system, First order & second order system

SEMESTER III and IV

BIO 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

BIO 5001 ANIMAL AND PLANT BIOTECHNOLOGY [4 0 0 4]

Plant Genome; Totipotency, Regeneration of plants; Autotrophic and heterotrophic growth, Plant growth regulators and elicitors, Cell suspension culture development; Production of secondary metabolites, Hairy root cultures & their cultivation; Direct and indirect methods; Chemical; Biological; Patents & PBRs; Animal cell metabolism & growth characteristics, Regulation & nutritional requirements; Substrate and product transport through mammalian cell, growth kinetics and shear force. Micro & Macro carrier attached growth, Cell culture in continuous, perfusion & hollow-fiber reactor; Hybridioma technology, Livestock improvement, Gene transfer methods, Transgenic animals, Xenotransplantation, cell preservation; IPR issues

References:

1. Dixon R.A and Gonzales, Plant Cell Culture: A Practical Approach, IRL Press, 1995.
2. Lindsey. K and M.G.K. Jones, Plant Biotechnology in Agriculture, Prentice Hall, New Jersey, 1990.

BIO 5002 BIOMOLECULAR DATA ANALYTICS [4 0 0 4]

DNA, RNA, Flow of genetic information, Genetic code, Transcription, Translation, HGP & Digital code of Life; Sequence Databases, Nucleotide & protein databases. Information retrieval; PDB; MMDB at NCBI, Structure file formats; evolutionary basis of sequence alignment, Modular Nature of proteins, Optional Alignment Methods, BLAST, FASTA, Low-Complexity Regions, Repetitive Elements. Pairwise & Multiple sequence alignment; Proteins - Secondary structures, Motifs, Domains, Tertiary & quaternary structures- Ramachandran plot; RNA structure; Ribosome; RNA Secondary Structure Prediction, Set & Graph theory, Strings & Algorithms, Chemical graphs; Hierarchical Levels in Biodiversity, Genetic diversity; Biodiversity issues; Methods for species identification & classification, Biodiversity Databases; Tree of life project, Elements of phylogenetic Models, Phylogenetic Data Analysis, Substitution Model Building, Tree Building & Evaluation, Building the Data Model (Alignment), Determining the Substitution Model, Tree -Building Methods, Searching for Trees, Rooting Trees, Evaluating Trees & Data, Phylogenetic software; companies & patents, IPR issues, Patents, copyright & Patenting.

References:

1. David W Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor, 2001.
2. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2002.

BIO 5003 BIOPOLYMER TECHNOLOGY [4 0 0 4]

Biopolymers produced from various renewable resources, characteristics, merits and demerits over conventional polymers; Biopolymers and Artificial Biopolymers in BiomedicalApplications, an Overview, Novel Synthesis of Biopolymers and Their Medical Applications, Composite Films Based on Poly (Vinylalcohol) and Lignocellulosic Fibres: Preparation and Characterizations, Composite Materials Based on Gelatin and Fillers from Renewable Resources: Thermal and Mechanical Properties, Properties of PHAs and Their Correlation to Fermentation Conditions; Synthesis and modification of xanthum gum, PHA, PHB Biosurfactants: Source, characteristics and properties of Biosurfactants; Production of Biosurfactants via the fermentation and biotransformation routes; Production of Biosurfactants with immobilized cells; Integrated bioprocess for continuous production of Biosurfactants including downstream processing; Applications of Biosurfactants – Food Industry, Environmental Control; Material Testing and Analytical Methods: Comparison of Test Systems for the Examination of the Fermentability of Biodegradable Materials, Structure-Biodegradability Relationship of biopolymers;Case studies: Optimization of production and purification of Xanthum gum and other biopolymers like PHA, PHB

References:

1. Emo Chiellini and Helena Gil**,** Biorelated Polymers: Sustainable Polymer Science and Technology, Springer 2001.
2. Johnson .R.M, L.Y. Mwaikambo and N. Tucker, Biopolymers**,** Rapra Technology, 2003.

BIO 5004 DESIGN AND DEVELOPMENT OF BIOLOGICAL TREATMENT PROCESSES [4 0 0 4]

Introduction, decomposition of organic carbon compounds; Biology, Mass, energy balance for aerobic & anaerobic respiration, Aerobic and anaerobic decomposition of glucose, protein, carbohydrates, lipids; Nitrogen removal, phosphorous removal, biosorption, Parametrs effecting the biological treatment: MLSS, MLVSS, F/M ratio, BOD and significance, Model and fitting kinetic parameter-Least square, Fujimoto, Daily difference, Thomas and Moments-Methods, Activated sludge process - plant configurations; Modeling of aerobic waste water treatment process; Design of activated sludge process for BOD removal, Nitrification & Denitrification, Design of the final (secondary) clarifier, Design of SBR, Reactor systems for anaerobic process, Disinfection-various methods, CHICKS –WATSON EQUATION AND APPLICATION ,Water reuse – Processes involved, risk assessment, Water Reclamation Technologies, Industrial water reuse

References:

1. Jordening H.J and J. Winter, Environmental Biotechnology- Concepts and Applications, Cambridge University Press,2006.
2. George Tchobanoglous and Franlin L. Burton, Wastewater Engineering-Treatment, Disposal and Reuse, Tata McGraw Hill Publishing Co.Ltd,1990.

BIO 5005 ENVIRONMENTAL BIOTECHNOLOGY [4 0 0 4]

Microbial flora of soil, growth, interactions among soil microorganisms, biogeochemical role of soil microorganisms.Simple aromatics, chlorinated, polyaromatic, petroleum products, pesticides and surfactants. Waste water characteristics, biological waste water treatment, activated -sludge process, mathematical modeling of anaerobic-digester dynamics; Biotechnology processes for oil; Bioremediation processes Ultra filtration systems for waste water contaminant removal; industrial waste treatment opportunities for reverse osmosis and ultrafiltration. Bio-hazard Monitoring and Control; Energy recovery systems for urban waste gasification of wastes fuels and chemicals from crops, production of oil from wood waste, fuels from wood waste, methanol production; Renewable and non-renewable resources. Biotechnological inputs in producing good quality natural fibres. Treatment of municipal waste and industrial effluents.Degradation of Pesticides and other toxic chemicals by Microorganisms Thuringiensis toxin as a natural pesticide.Biological control of other insects swarming the agriculture fields. Enrichment of ores by microorganisms.Biofertilizers Nitrogen fixing microorganisms

References:

1. Foster C.F. and D.A. John Ware, Environmental Biotechnology, Ellis Horwood Limited, 1987.
2. Larry Anderson and David A, Fuels from waste, Tillman, Academic Press, 1997.

BIO 5007 IMMUNOTECHNOLOGY [4 0 0 4]

Innate and adaptive immunity. Lymphocytes - their origin and differentiation; antigens - their structure and classification; complement; types of immune responses; anatomy of immune response; B-lymphocytes and activation; structure and function of immunoglobulins;. Genetic control of antibody production. monoclonal antibodies; idiotypes and idiotypic antibodies. MHC; Blood Typing; Cellular Immunology: Thymus-derived lymphocytes - classification. APC - macrophages. dendritic cells. langerhans cells;; mechanisms of phagocytosis; immunosuppression. Immune tolerance; Antigen Antibody interactions; RIA, ELISA, Chemiluminescence, ELIspot, FACS, western blotting, Immuno fluorescence, immuno precipitation, immuno diffusion, immunoelectrophoresis. Immuno Histochemistry and IHC methods. Immuno electron microscopy; stem cells and applications to immunology, Immunosuppressive drugs. HLA; Autoimmunity; Vaccines, Immunotherapy.

References:

1. Roitt I, Essential Immunology , Blackwell Scientific Publications, Oxford press ,1991.
2. Kuby J and WH Freeman, Immunology (6e), New York, 2007.

BIO 5008 IPR ISSUES IN BIOTECHNOLOGY AND BIOSAFETY [4 0 0 4]

Public acceptance issues for biotechnology: Case studies/experiences from developing and developed countries. The Cartagena protocol on biosafety. Biosafety management: Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. The legal and socioeconomic impacts of biotechnology, Biosafety regulations and National and International guidelines with regard to rDNA technology, transgenic science, GM crops, Good manufacturing practice and Good lab practice (GMO and GLP). Environmental aspects of biotech application. Special procedures for rDNA based product production. Intellectual property rights (IPR), WTO-GATT, TRIPS, international conventions patents and methods of applications of patents. Plant breeder's rights.Examples of patents in biotechnology.Special application of patent laws in biotechnology. Licensing and cross licensing; Identification of directions for yield, effect in agriculture, aquaculture;.Ethics and Biosafety aspects in Bioremediation.

References:

1. Biotechnologies and Development, UNESCO Publications, 1988
2. A Biotechnologies in developing countries present and future, UNESCO Publishers, 1993

BIO 5009 PHARMACEUTICAL BIOTECHNOLOGY [4 0 0 4]

Pharmaco-Kinetics-absorption of drugs, distribution of drugs, protein binding of drugs, Manufacture of Macromoleucles, Traditional pharmaceuticals; Compartment modeling- non linear kinetics, bioavailability & bioequivalence, excretion of drugs; Drug discovery, Patenting; Role and remit of regulatory authorities; European regulations, Guides to good manufacturing practice, Formulation and Delivery Issues of Therapeutic Proteins, Biotechnology-Derived Drug Products: Formulation Development, Stability Testing, Dosage Forms, Excipients, wet & dry granulation, tablet formulation, coating, capsules, oral liquids, ointments, therapeutic enzymes, laxatives, analgesics, non steroidal contraceptives, antiseptics, antacids, antibiotics; Strategy & Phasing for Drug Safety Evaluation; Human Pharmaceutical Safety, Acute Toxicity Testing, Preclinical Evaluation, Immunotoxicology Quality Assurance

References:

1. Heinrich Klefenz, Industrial pharmaceutical biotechnology, John Wiley sons, 2002.
2. Susanna Wu-Pong, Yongyut Rojanasakul, and Joseph Robinson, Biopharmaceutical drug and design and development, Humana Press, 2007.

BIO 5010 SOLID WASTE MANAGEMENT [4 0 0 4]

Integrated solid waste management, operation of waste management systems. Legislative Trends and Impacts; Composition of municipal solid wastes, Properties of MSW; transformations of solid waste; Properties, classification and transformation of Hazardous wastes and its management; Collection of solid waste, Separation, processing and Transformation of solid waste, Transfer and Transport, Disposal; Landfill methods & its design; Biological principles, aerobic composting, Anaerobic digestion, Biological transformation processes. Energy production from biological conversion products, Fermentation and compost processes: design parameters & Applications; Meeting federal and state mandated diversion goals; Recycling, Implementation of solid waste management options; planning, siting and permitting of waste management facilities.

References:

1. George Tchobanoglous, Integrated solid waste management: Engineering principles and management issues, McGraw Hill, 1993.
2. William D Robinson, The solid waste handbook: A practical guide, John Willy & sons, 1986.

BIO 5011 STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY [4 0 0 4]

Errors in Data and calculations, presentation of experimental data, data analysis, general procedures for plotting data, process flow diagrams; Classical versus statistical approaches to experimentation, diagnosing the experimental environment, good design requirements. Introduction to factorial designs, definitions and principles, Basic Two-level factorial design experiments, 2k factorial design; Fractionating factorial designs, fractional factorial designs, Plackett-Burmann screening designs; Response surface methodology – concepts & methods, design considerations, central composite designs and Box-Behnken response surface design; Optimizations of Media components, fermentation process and purification process with specific case studies by using statistical software.

References:

1. Lawson J & Erjavec J, Modern Statistics for Engineering and Quality Improvement (1e), Duxbury Press, 2001.
2. Montgomery Douglas C , Design and analysis of experiments (6e), John Wiley, 2009.

BIO 5012 SYSTEMS BIOLOGY [3 1 0 4]

Introduction to systems biology:The challenge of biological complexity,Modularity, Trends and drivers; Basic principles:Model assignment,Purpose and adequateness of models; System structure identification, Approaches to building a system,System behavior analysis, Typical aspects of biological systems and corresponding models: Robustness and Sensitivity; Data integration in systems biology; Modeling of Biochemical Systems:Enzyme kinetics and thermodynamics, Deriving a rate equation; Parameter estimation and linearization; Metabolic flux analysis: Systems equations, Elementary flux modes and extreme pathways; Flux balance analysis; Compartments and transport across membranes, Metabolic control analysis, Modeling of Signaling Pathways:Structural components of signaling pathways, MAP kinase cascades, Jak-Stat pathways Signaling: Dynamic and Regulatory Features, Applications and case studies of systems biology.

References:

1. Theoretical and Applied Aspects of Systems Biology Series: Computational Biology 27, Fabricio Alves Barbosa da Silva, Nicolas Carels, Floriano Paes Silva Junior, Springer International Publishing AG, 2018.
2. Systems Biology, Jens Nielsen Stefan Hohmann, Wiley VCH Verlag GmbH & Co. KGaA, 2017.

OPEN ELECTIVES

BIO 5051 BIONANOTECHNOLOGY [3 0 0 3]

Introduction and scope of Bionanotechnology, Bionanomachines: Negligible gravity & inertia, atomic granularity, thermal motion, water environment, Role of biomolecules in biomaterials; Synthesis of Biomolecules: rDNA Tech, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures; X-Ray crystallography, NMR spectroscopy, Electron & Atomic force microscopy. Molecular modeling tools; Protein folding prediction, homology modeling, Docking simulation & Computer-assisted molecular design; Protein folding; Self assembly, Self-organization; Energetics, allosteric motion & covalent modification; Structure & functional properties of Biomaterials, Bimolecular motors; Traffic across membranes; Bimolecular sensing, Self replication, Machine-Phase Bionanotechnology; Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors.

References:

1. David S Goodsell , Bionanotechnology, John Wiley & Sons, 2004.
2. Greco Ralph S , Nanoscale Technology in Biological Systems, CRC Press, 2005.

BIO 5052 INTRODUCTION TO BIOFUELS AND BIOPOLYMERS [3 0 0 3]

Biofuels: Renewable energies and significance; Feedstocks for various biofuels; LCA of biofuels; Ethanol from fermentation and comparison of different technologies; Diesel from Jatropha, waste cooking oils & Microalgae; Biogas and biological hydrogen; Basic concepts of microbial fuel cells. Biopolymers: Introduction; Biopolymers vs Synthetic polymers; Synthesis of biopolymers; Commercially available biopolymers; Uses of biopolymers; Manufacturing technologies; Fillers & Reinforcement; Market & Economics; Biodegradability.

References:

1. Caye M. Drapcho, N.P. Nhuan and T. H. Walker, Biofuels Engineering Process Technology , Mc Graw Hill Publishers, New York, 2008.
2. Jonathan R.M, Biofuels – Methods and Protocols (Methods in Molecular Biology Series), Humana Press, New York, 2009.
3. Mohanty, A.K., et al., Natural Fibers, Biopolymers, and Biocomposites, CRC Press, 2005
4. R.M. Johnson, L.Y. Mwaikambo and N. Tucker, Biopolymers**,** Rapra technology 2003

Department of Chemical Engineering

Chemical Engineering explores the processing of materials and the production or utilization of energy through chemical and/or biochemical routes. Chemical engineers play a key role in petroleum, fertilizers and plastic industries, and in the production of novel & composite materials and Intermediate & speciality chemicals. Chemical engineers make use of their expertise to find solutions to environmental hazards such as pollution and harmful chemicals delivered by several other industries. Chemical engineering graduates typically work in chemical process industries, biotechnology, environmental remediation, food processing, pharmaceuticals, energy and polymers.

The department of Chemical Engineering established in the year 1969 and the first batch of Chemical Engineers graduated in 1974. Till date, 47 batches of students (about 2200 Chemical Engineers) have been graduated from the department. The department is having MoU with University of Nottingham and University of South Alabama for the post graduate studies.

Core Competencies of the Department are:

- Process Modelling & Simulation
- Fluid & Fluid-Solid Operations
- Drug Delivery Systems
- Environmental Pollution Control
- Catalysis and Nanotechnology
- Reaction Engineering
- Renewable Energy
- Process Control
- Bio Remediation

Programs offered

Under Graduate Program

- B.Tech in Chemical Engineering (1969)

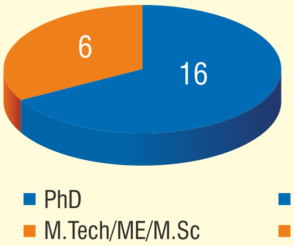
Post Graduate Programs

- M.Tech in Chemical Engineering (2009)

PhD

Faculty Strength

Qualification-wise



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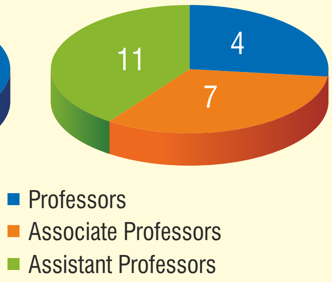
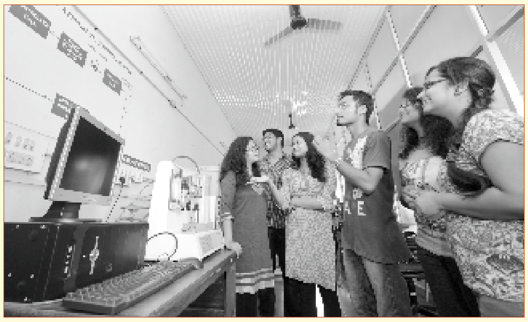




DEPARTMENT OF CHEMICAL ENGINEERING, MIT Manipal

M.TECH. CHEMICAL ENGINEERING

Course Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5158	Mathematical and Numerical Techniques in Chemical and BiologicalEngineering	3	1	0	4	CHE 5251	Optimization of Chemical Processes	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CHE 5252	Process Modelling, Analysis and Simulation	3	1	0	4
	CHE 5151	Advanced Control Theory	3	1	0	4	CHE ****	Program Elective I	4	0	0	4
	CHE 5152	Advanced Reaction Engineering	3	1	0	4	CHE ****	Program Elective II	4	0	0	4
	CHE 5153	Advanced Transport Phenomena	3	1	0	4	CHE ****	Program Elective III	4	0	0	4
	CHE 5154	Process Design of Chemical Equipment	3	1	0	4	******	Open Elective	3	0	0	3
	CHE 5161	Advanced Chemical Engineering Lab	0	0	3	1	CHE 5261	Advanced Process Control Lab	0	0	3	1
	CHE 5162	Computational Methods for Chemical Engineering Lab	0	0	6	2	CHE 5262	Process Simulation Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**21**	**2**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	CHE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CHE 5001	Air Pollution Monitoring and Control	CHE 5008	Metabolic Engineering
CHE 5002	Bioprocess Engineering	CHE 5009	Nano Science and Technology
CHE 5003	Environmental Management System	CHE 5010	Pinch Technology
CHE 5004	Fuel Cell and Hydrogen Energy	CHE 5011	Process Data Analysis
CHE 5005	Industrial Waste Water Engineering	CHE 5012	Solid Waste Management
CHE 5006	Interfacial Science and Engineering	CHE 5013	Upstream and Downstream Bioprocessing
CHE 5007	Membrane Science and Technology		

OPEN ELECTIVES			
CHE 5051	Advanced Separation Processes	CHE 5052	Green Processes

SEMESTER I

MAT 5158 MATHEMATICAL AND NUMERICAL TECHNIQUES IN CHEMICAL AND BIOLOGICAL ENGINEERING [3 1 0 4]

Solution of system of linear equations: LU decomposition method, Cholesky decomposition method, Partition method, Gauss Seidel method, Relaxation method, Eigen values and Eigen vectors of Matrices, Jacobi's method, Given's method, Rayleigh's Power method. Numerical Integration-Newton-Cote's formula, Romberg integration, Regression-Linear, Polynomial, multiple linear, Non-linear regression, problems on L5-L6 Orthogonal polynomials, Method of least squares for continuous functions, Gram-Schmidst's Orthogonalization process. Algebraic and transcendental equations: Bairstow method, Chebyshev method, Newton-Raphson method and Multivariable Newton-Raphson method, Birge-Vieta method. Numerical solution of differential equations-Initial value problems and boundary value problems: Runge- Kutta method for simultaneous differential equations and higher order differential equations, Shooting method, Finite difference method, Numerical Solution of Partial Differential Equations: Classification, Canonical forms, Characteristics, Finite difference approximation to derivatives of Parabolic, Elliptic and Hyperbolic P.D.E, Explicit and Implicit finite difference methods, Finite element methods. Multivariate non-linear optimization without constraints- Gradient vector and Hassian matrix, The method of Steepest ascent, The Newton Raphson method.

References:

1. Jain M.K., Iyengar S.R.K. and Jain R.K., *Numerical methods for scientific and engineering computation,* New age international (P) Limited, Publishers.
2. Santhosh K.G., *Numerical methods for Engineer*, Wiley Eastern Ltd, New Delhi.
3. Sastry S.S., *Introductory Methods of Numerical Analysis*, 4e, PHI Publishers
4. Pushpavanam S., *Mathematical methods in Chemical engineering,* 1e, PH Learning Pvt.Ltd.
5. Thomas J. W., *Numerical Partial Differential Equations: Finite Difference Methods*, Springer Verlag.
6. Grewal B.S, *Numerical methods in engineering & Science with programs in C & C++,* Khanna Publishers.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Ranjit K., *Research Methodology: A Step-by-Step Guide for Beginners,* SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, *Essentials of Research Design and Methodology*, John Wiley & Sons, 2004.
3. John W. C , *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE, 2004
4. Suresh C. Sinha and Anil K. D., *Research Methodology* (2 Vols-Set), Vedam Books, 2006.
5. Kothari C. R., *Research Methodology: Methods and Techniques*, New Age International Publisher, 2008.
6. Donald R C.& Pamela S S. , *Business Research Methods*, McGraw Hill International, 2007.
7. Pannershelvam R., *Research Methodology*, Prentice Hall, India, 2006
8. Manfred M. B., *Mixed Methods Research*, SAGE Books, 2006.
9. Paul S. G., Williamson J.B., David A. K., John R. D., *The Research Imagination*, Cambridge University press, 2007.
10. Cochrain & Cox*, Experimental Designs*, II Edn. Wiley Publishers, 2006.

CHE 5151 ADVANCED CONTROL THEORY [3 1 0 4]

Review of linear control theory and its application, SISO and MIMO systems, Enhancement of SISO loop control performance and its applications. Case studies for MIMO system, Dynamics of MIMO system using State space method, centralized control of MIMO system, Models for computer control. Control relevant models, Introduction to discrete time system and analysis using Z-transform. Development pulse transfer function. Discrete state space representation. Stability of linear discrete systems. Models for computer control from input-output data. Discrete dynamic models, Parameter estimation problem. Prediction error methods, Parameter estimation of Black box models (i.e. ARX, ARMAX Models). State Estimator & model predictive control: Application of each of the theory on chemical process systems.

References:

1. Seborg D.E., Edgar T.F., Mellichamp, *Process dynamics and control*, (2e), John Wiley & sons, 2004
2. Harmon Ray W., Babatunde Ogunnaike. *Process dynamics, modeling and control*, (1e), Oxford University press. 1994
3. Wayne Bequette B., *Process control, Modelling, analysis and simulation*, (2e), Prentice Hall Int. Series. 2003.
4. Arun K. Tangirala, *Principles of System Identification: Theory and Practice*, CRC Press, 2014.
5. Ogata K., *Discrete Time Control systems*, (2e),Pearson Education, 2005.
6. Astrom K.J., and Wittermark B., *Computer-Controlled Systems: Theory and Design*, (3e),Prentice Hall, 1996

CHE 5152 ADVANCED REACTION ENGINEERING [3 1 0 4]

Non-ideal flow in reactors: RTD, dispersed plug flow and tanks in series model, design aspects of reactors with non-ideal flow. Theory of Mass transfer with chemical reaction, model contactors.

Kinetics of solid-catalysed gas phase reactions: Diffusion with reaction in porous catalyst, Mechanism of catalytic reactions. Development of rate equations for solid catalysed fluid phase reactions; Estimation of kinetic parameters External/internal mass and heat transfer resistances in catalyst particles. Muti-phase Reactor engineering: Hydrodynamic characteristics of different reactors; mechanically agitated contactors, bubble columns, slurry reactors, spray columns, etc. Design aspects of multiphase reactors: pressure drop, fractional phase hold-up, mass and heat transfer coefficient, extent of mixing, etc.

References:
1. Levenspiel O., *Chemical Reaction Engineering*, Wiley & Sons - 3rd Edition, 2003.
2. Smith, J.M, *Chemical Engineering Kinetics*, 3rd Edition, Mc Graw Hill, International Student Edition
3. Fogler S , H, *Elements of Chemical Reaction Engineering* – PH- 4th Edition- 2005
4. Froment G.F. And Bischoff, K.B., Chemical Reactor Design and Analysis, (2e), John Wiley and Sons NY, 1997
5. Doraiswamy L.K. And Sharma M.M., *Heterogeneous Reactions: Analysis, Examples and Reactor Design,* Volume 1& 2, John Wiley & Sons Inc., 1st Edition-1994
6. Danckwerts P.V., *Gas Liquid Reactions*, Mc Graw Hill Book Co., New York (1970)

CHE 5153 ADVANCED TRANSPORT PHENOMENA [3 1 0 4]

Review of fundamental of momentum, mass and energy transfer. Equation of change in momentum, mass and energy –steady state solutions- velocity, temperature, concentration distribution in more than one independent variable in viscous and turbulent flow. Integral averaging in momentum, mass and energy transfer. Interphase transport in isothermal, non isothermal and multicomponent systems. Microscopic balance for isothermal, non isothermal and multicomponent systems.

References:
1. Bird,R .B., Stewart, W.E. and Lightfoot, E.W. *Transport Phenomena*, (2e), Wiley, 1994.
2. Robert S.B., Harry.C.. *Transport Phenomena-A unified approach*, (1e), McGraw Hill Int., 1988.
3. Slattery J. C., *Advanced Transport Phenomena*, (2e), Cambridge University Press -1999.

CHE 5154 PROCESS DESIGN OF CHEMICAL EQUIPMENT [3 1 0 4]

Prediction of physical properties needed for design calculations: Density, thermal conductivity, specific heat capacity, viscosity, diffusivity, surface tension, latent heat, phase equilibrium data, enthalpy. Process design of Heat Transfer equipment: Heat exchangers, condensers, reboilers, vaporisers. Process design of Mass Transfer equipment: Distillation column, absorption column, liquid-liquid extraction column. Process design of simultaneous heat and mass transfer equipment: Evaporator, dryer, cooling tower.

References:
1. Gavin T. & Ray S., *Chemical engineering design-Principles, Practice and Economics of Plant and Process Design* , Butterworth and Heinemann(Elsevier),2008.
2. Stanley W., *Chemical Process equipment- Selection and Design*, Butterworth and Heinemann ,1990.
3. Don G. and Robert P., *Chemical Engineers Handbook*, McGraw Hill, 9th edition,2018

CHE 5161 ADVANCED CHEMICAL ENGINEERING LABORATORY [0 0 3 1]

Experiments involving unit operations, chemical reaction engineering, analytical instruments and image processing of droplets.

CHE 5162 COMPUTATIONAL METHODS FOR CHEMICAL ENGINEERING LABORATORY [0 0 6 2]

Introduction to MATLAB, Coding using MATLAB for simple system analysis, Solution of non-linear algebraic equation, Regression and Optimization, Solution of linear differential equation. Regression and Optimization, Solution of partial differential equations, Dynamic and steady simulation of chemical process. Simulink exercises. Two level factorial design of experiments for a given experimental data.

References:
1. Gupta S.K., *Numerical methods for Engineer*, Wiley Eastern Ltd, 1995
2. Pushpavanam S., *Mathematical methods in Chemical engineering,* (1e), PH Learning Pvt.Ltd.,2005.
3. Canale R.P. and Chapra S.C , *Numerical Methods for Engineers*, , (7e),McGraw Hill, 2015
4. Montgomery D.C., *Design and Analysis of Experiments*, (8e), Wiley, 2012.

SEMESTER II

CHE 5251 OPTIMIZATION OF CHEMICAL PROCESSES [3 1 0 4]

Introduction to Optimization: Optimal problem formulation, Design variables, constraints, Objective function, the nature and organization of optimization – the essential features of optimization problems. Optimization theory and methods – Basic concepts of optimization-Convex and Concave functions. Optimization of un-constrained functions: Single variable optimization Algorithm: Multivariable Optimization Algorithm for un-constrained functions: Optimality criteria, Constrained Optimization Problem. Linear programming and applications, Geometry of Linear programming, Simplex Algorithm. Necessary and Sufficient Condition for optimality. Direct and gradient based methods for constrained optimization problem. Nonlinear programming with constraints, Introduction to Mixed integer programming. Problem formulation, Branch and bound methods. Application of optimization in chemical engineering systems. Introduction non-traditional optimization algorithms.

References:
1. Edgar T.F, Himmelblau D.M., Ladson L.S., *Optimization of chemical processes*, (2e), Mc Graw Hill international Editions, 2003
2. Rao S.S, *Engg. Optimization-theory and practice*, (4e), John wile and sons, 2009.
3. Joshi M.C. and Moudagalya K. M., *Optimizations, Theory and practice*, (1e), Narosa Pub, New Delhi, 2008.
4. Kalyanmoy D., *Optimization for Engineering design; Algorithm and Examples*, PHI, New Delhi, 2009.

CHE 5252 PROCESS MODELING, ANALYSIS AND SIMULATION [3 1 0 4]

Fundamental principles and process model development. Systematic approach to model building, Conservation principles, Constitutive relations, Dynamic models- Lumped parameters and distributed parameter systems and their solution strategies. Introduction to Process model hierarchies and basic tools for process model analysis, Introduction to data acquisition and analysis, statistical model calibration and validation. Modeling discrete event systems, Modeling hybrid systems, Introduction to Computer aided process modeling, Empirical model building. Introduction to basic mathematical tools.

References:
1. Hangos K. M.,Cameron I. T., *Process modeling and analysis* (1e), Academic press. 2007
2. Ramirez, W, *Computational methods in process simulation* (2e), Butterworths, NY 2000
3. Ingham J., Dunn I.J., Heinzle E., Peensoil J.E., *Chemical Engineering Dynamics, Modelling and Computer Simulation*, (3e), Wiley VCH, Verlog, GMbH & LOKGaA-2007

CHE 5261 ADVANCED PROCESS CONTROL LAB [0 0 3 1]

Data driven model development, Design of conventional controller for SISO system, Data driven model development using system identification toolbox for MIMO system. Design and validation of decoupler for MIMO system. Design of P/PI/PID controller for SISO and MIMO system. Design of model based controller for SISO and MIMO system.

References:

1. Seborg D.E., Edgar T.F., Mellichamp*, Process dynamics and control*, (2e), John Wiley & sons, 2004
2. Astrom K. J. and Wittermark B., *Computer-Controlled Systems: Theory and Design*, Prentice Hall; 3 edition, 1996
3. Tangirala A. K., *Principles of System Identification: Theory and Practice*, CRC Press, 2014.

CHE 5262 PROCESS SIMULATION LAB [0 0 3 1]

Introduction to simulation software packages, Aspen Plus. Dynamic simulation practice sessions with software for unsteady state and dynamic simulation of chemical process plants.

References:

1. Amiya K Jana , *Process simulation and control using ASPEN*, (2e), Prentice Hall India,2012
2. Bruce A Finlayson, *Introduction to chemical engineering computing*, John Wiley & sons, 2006

SEMESTER III and IV

CHE 6098 PROJECT WORK [0 0 0 25]

The M.Tech project is aimed at training the students to analyses independently any problems posed to them. The project may be theoretical, experimental or a combination. In few cases the project may also involve sophisticated design work. The project report is expected to show the clarity of thought and expression, critical appreciation of existing literature and analytical, experimental skills. This can be carried out either in the institute or at any other industry/research laboratory in India or Abroad under the supervision of guide(s). The project should be completed and submitted for evaluation at the end of the year.

PROGRAM ELECTIVES

CHE 5001 AIR POLLUTION MONITORING AND CONTROL [3 1 0 4]

Design of air monitoring survey networks criteria, models for monitoring site selection, principles and techniques for ambient and stack sampling, acquisition and analysis of monitored data, environmental indices Meterological monitoring and instrumentation, collection analysis and wind data, determination of atmospheric stability of wind roses and pollution roses principles methods Monitoring gaseous air pollutants like SO_2, H_2S, CO,CO_2 NOx, Hydrocarbons, collection and size analysis of particulates BS methods. Alternative routes of manufacturing and/or segruneing operation for pollution control and recovery of chemicals, Removal/recovery/destruction methods for Sox, NOx, Cl_2, F_2, Hg, H2S organic vapours and particulate matter through unit processes and unit operation like mass transfer, gas absorption, adsorption, filtration, membrane separation and chemical oxidation.

References:

1. Noll K.E and Miller T.L., *Air Monitoring survey design*, (1e), Ann Arber Science, 1977
2. Khopkar S.M., *Basic concepts of Analytical chemistry*, (1e), Wiley Eastern, 1981.
3. Perkin A.C, *Air Pollution*, (1e), McGraw-Hill 1974.
4. Allegrini I., Santis F.De , *Urban air pollution monitoring and control strategies*, (NATO ASI Series, (1e)), Springer Verlag, 1996.
5. Khopkar S.M., *Environmental pollution Monitoring and control*, (1e), New Age Int, ND – 2004.

CHE 5002 BIOPROCESS ENGINEERING [4 0 0 4]

Microbiology and biochemistry fundamentals. Bioprocess principles: Kinetics of biomass, substrate and product. Batch, continuous and Fed-batch cultures. Fermentation processes: General requirements, aerobic and anaerobic fermentations. Types of media and design of commercial media. Thermal death kinetics, heat sterilizations and filter stabilizations. Enzyme technology: enzymes classification and properties, kinetics of enzyme catalytic reaction. Bioreactor design and scale up. Mass transfer and heat transfer processes in biological systems. Recovery and purification of products. Process control in bioprocesses: Measurement and control of various physical and chemical parameters.

References:

1. Micheal L. Shuler and Karji F., *Bioprocess Engineering: Basic Concepts*, (2e),Prentice Hall India, 2015.
2. Stanbury P.F., Whitakar A., Hall S.J., *Principles of Fermentation Technology*, Elsevier Publishers, (2e), 2005.
3. Pauline M. D., *Bioprocess engineering principles*, (1e), Academic press. 1995

CHE 5003 ENVIRONMENTAL MANAGEMENT SYSTEM [4 0 0 4]

Introduction to air, water and air pollutants and solid wastes, Sampling and analysis techniques. Introduction and need for Impact assessment National and International regulation-legislation and pollution control acts and notifications, ISO series. Application of Impact assessment in specific developmental projects-Impact assessment report, Concepts for development projects-Ranking Impacts-concept and content of environmental management plan-Environmental audits, Life cycle analysis, sustainable development-parameters, Case studies Industrial symbiosis-clean technology options.

References:

1. Wathern P., *Environmental Impact assessment-Theory and practice*, (1e), Unwin Hyman Ltd, 1988.
2. Lee L H., *Environmental Health and Safety Auditing Hand Book*, (2e), McGraw Hill NewYork, 1995.
3. Noel D., *Air pollution control Engineering,* (2e), McGraw hill 1999.
4. Tapas K.D., *Toward Zero discharge Innovative Methodology and Techniques for process*

Pollution, (1e), Wiley-VCH-2005.

CHE 5004 FUEL CELL & HYDROGEN ENERGY [4 0 0 4]

Hydrogen energy - Hydrogen: Hydrogen production methods, Fuel cell BASICS, Fuel cell thermodynamics, Fuel cell types, Fuel Cell Performance, Activation, Ohmic and Concentration over potential, Fuel cell design and components, Overview of intermediate/high-temperature fuel cells, Current issues in fuel cells

References:

1. Larminie J. and Dicks A., *Fuel Cell Systems Explained*, 2nd Edition, Wiley (2003)
2. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis (2005)
3. Srinivasan S., *Fuel Cells: From fundamentals to Applications*, Springer (2006)'
4. O'Hayre, S.W.Cha, W.Colella and F.B.Prinz, *Fuel Cell Fundamentals*, Wiley (2005)
5. Bard A.J. and.Faulkner L.R, *Electrochemical Methods: Fundamentals and Applications*, 2nd Edition, Wiley 2000.

6. Faghri A and Zhang Y., *Transport Phenomena in Multiphase Systems*, Elsevier 2006.

CHE 5005 INDUSTRIAL WASTE WATER ENGINEERING [3 1 0 4]

Water Quality- Water Quality requirements- Physical processes- chemical processes and biological processes-Primary, Secondary and tertiary treatment-Unit operations-Unit processes- Sources and types of industrial wastewater –Design of wastewater treatment systems- Primary, secondary and tertiary treatments- Evaluation of Biokinetic Parameters -Activated Sludge and its process- Modifications. Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors Waste stabilization ponds and Lagoons Aerobic pond, facultative pond, anaerobic ponds- polishing ponds, aerated Lagoons Anaerobic processes-Process fundamentals-Standard, high rate and hybrid reactors, Anaerobic filters. Expanded /fluidized bed reactors-Upflow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Sludge Digestion, Sludge disposal-Waste minimization - Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – adsorption –Chemical oxidation – Ozonation – Photocatalysis – Disinfection-Wet Air Oxidation – Ion Exchange – Membrane Technologies - Reverse osmosis, Ultrafiltration, Electrodialysis.

References:

1. Weber, W.J., *Physicochemical processes for water quality control*, John Wiley and sons, New York, 1983.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G., *Environmental Engineering*, McGraw Hills, New York 1985.
3. Metcalf and Eddy, *Wastewater engineering, Treatment and Reuse*, Tata McGraw-Hill, New Delhi, 2003.
4. Benefield, L.D. and Randall C.W., *Biological Processes Design for wastewaters*, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.
5. Eckenfelder, W.W., *Industrial Water Pollution Control*, McGraw-Hill, 1999.
6. Arceivala, S.J., *Wastewater Treatment for Pollution Control*, McGraw-Hill, 1998.
7. Frank Woodard, *Industrial waste treatment Handbook*, Butterworth Heinemann, 2001
1. 8.Grady Jr. C.P.L and Lin H.C., *Biological wastewater treatment: Theory and Applications*,Marcel Dekker, Inc New York, 1980

CHE 5006 INTERFACIAL SCIENCE & ENGINEERING [4 0 0 4]

Introduction of colloids and interfaces, The role of mixing and entropy, Colloid stability, Van der Waals forces, Electrical phenomena at interfaces, Spreading of droplets, Experimental interrogation of colloids and surfaces, Understanding adsorption at surfaces; Self –assembly of Amphiphiles, The hydrophobic effect, The effect of counter ions, Phospholipids and cell membranes, Particles at interfaces, Novel fabrication of nanostructured particles, Electron transfer across interfaces, Latest trends in interfacial science and latest innovation in interfacial engineering applications.

References:

1 Hiemenz, P. C, Rajagopalan, R., *Principles of Colloid and Surface Chemistry, (3e),* Marcel Dekker, New York, 1997.
2. Rosen M. J., *Surfactants and Interfacial Phenomena, (1e),* Wiley-Interscience Publication, New York, 1978.
3. Adamson, A. W. Gast, A. P., *Physical Chemistry of Surfaces, (1e),* Wiley-Interscience, New York, 1997.
4. Fennell D. E., Wennerstrom K., *The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet (Advances in Interfacial Engineering)*, Wiley-VCH, 1999
5. Israechvili, *Intermolecular & Surface Forces, (2e),* Academic Press, 1992

CHE 5007 MEMBRANE SCIENCE & TECHNOLOGY [3 1 0 4]

Membrane preparation and structure, membrane permeability, flow pattern and classification: micro filtration, ultra filtration, nano filtration, reverse osmosis, electro dialysis, dialysis, membrane modules and plant configuration, liquid separation: pervaporation, vacuum membrane distillation, transport through membrane, solution diffusion model and other models.

Gas separation: complete mixing model (binary and multi component) for gas separation, cross flow model, counter current flow model, single stage membrane separation, multistage membrane separation and analogy with multi component distillation, differential permeation with point permeate withdrawal, bubble point type curve, dew point type curve.

Membrane reactor: perovskite type, bio catalytic membrane reactor, application of membrane in separation of optical isomers of valued bioactive materials. Transport through bio membrane like kidney.

References:

1. Hoffman E. J., *Membrane separations Technology: single-stage, Multistage, and Differential Permeation*, (1e), Gulf Professional Publishing, 2003.
2. Mulder M.H.V., *Membrane Separation*, (1e), Springer Publ. -2007.
3. Scott K.S., Hughes R. (Editors), *Industrial Membrane Separation Technology*, (1e), Blackie Academic & Professional Chapmann & Hall, Glasgaw, 1996

CHE 5008 METABOLIC ENGINEERING [4 0 0 4]

Review of cellular metabolism. Transport processes: passive and active transport, facilitated diffusion. Models for cellular reactions: Material balances and data consistency. Regulation of metabolic pathways, enhancement of product yield and productivity. Metabolic pathway synthesis. Metabolic flux analysis: experimental determination and applications. Metabolic control analysis: analysis of structure and metabolic networks, extension and control analysis, consistency tests and experimental validation, thermodynamics of cellular processes, Determination of G^o by various methods, applications of thermo kinetics to MCA.

References:

1. Stephanopoulos G.N, Aristose A. A., Nielsen J., *Metabolic engineering principles and Methodologies*, (1e), Academic press,1998.
2. Sang Y. L., Eleftherios T., Papoutsakis T., *Metabolic Engg*., (2e), CRC Press, 1999.
3. Khdoderko B.N., Thomas and Westerhoft B H.W., *Metabolic engg in Post Genomic Era*, (1e), Horizon Bio Science, Amsterdam, The Netherlands, 2004.

CHE 5009 NANO SCIENCE & TECHNOLOGY [4 0 0 4]

Basic concepts and definitions: materials science, nano science .Unusual and useful properties of nano materials. Applications of nano materials and market survey. Applications of Nano materials in energy and environmental engineering Challenges and opportunities in the synthesis and applications of nano materials. Methods of synthesis of nano materials "Top-down" vs. "bottom-up" approaches. Inorganic and organic nano materials. Vapour phase-CVD and liquid phase synthesis of nano materials- emulsion method, wet chemical method. Ultrasound assisted synthesis of nano materials. Carbon nano materials – fullerene, CNT, Graphene, CNT, carbon nano fiber. Inorganic nanowires.

Semiconductor nano materials- synthesis and applications. Functionalized nano materials. Supported nano materials. Core-shell nano particles. Nanofluids- synthesis, applications and characterization of nano particles

References:

1. Tang, Z.and Sheng P., *Nano science and technology: novel structures and phenomena*, Taylor and Francis, 2003
2. Michael R., *Nano-Engineering in Science and Technology: An Introduction to the World of Nano design*", World Scientific, 2003
3. Kelsall R., Hamley I. and Geoghegan M., *Nanoscale Science and Technology*, Wiley, 2005.
4. Ventra M. Di, Evoy S. and Heflin J. R., *Introduction to Nanoscale Science and Technology*, Springer, 2004.
5. Poole C. P., Owens Jr., F. J., *Introduction to Nanotechnology*, Wiley, 2003.
6. Pradeep T**,** Nano: The Essentials Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill, New Delhi, , 2012

CHE 5010 PINCH TECHNOLOGY [3 1 0 4]

Process Integration and its Building Blocks: Definition of Process Integration (PI), School of thoughts, Areas of application and Techniques available for PI, Onion diagram. Pinch Technology -An Overview: Introduction, Basic concept, How it is different from energy auditing, Role of thermodynamic laws, Problem addressed by Pinch technology. Key Steps of Pinch Technology: Data extraction, Targeting, Designing, Optimization- Super targeting. Basic Elements of Pinch Technology: Grid diagram, Composite curve, Problem table algorithm, Grand composite curve. Targeting of Heat Exchanger Network (HEN): Energy targeting, Area targeting, Number of units targeting, Shell targeting, cost targeting. Designing of HEN: Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER), Design of multiple utilities and pinches, Design for threshold problem, Loops and Paths. Heat Integration of Equipments: Heat engine, Heat pump, Distillation column, Reactor, Evaporator, Drier, Refrigeration systems. Heat and Power Integration: Co-generation, Steam turbine, Gas turbine.

References:

1. Uday S. V., *Heat Exchanger network synthesis*, (1e), Gulf Publishing Co, USA, 1995
2. Douglas J. M., *Conceptual Design of Chemical Processes*, (1e), McGraw Hill, New York, 1988.
3. Linnhoff, B. Townseod D.W., Boland D., Hewitt G.F., Thomas, B.E.A., Guy, A.R. and Marsland, R.H., *A User's guide on process integration for the efficient use of energy*, (1e), Inst. Of Chemical Engineers, London (1982).
4. Smith, R., *Chemical Process Design*, (1e), McGraw Hill (1995).

CHE 5011 PROCESS DATA ANALYSIS [3 1 0 4]

Fundamental statistical analysis, Simple regression analysis, Multiple regression analysis, Parameter estimation, grey model, black-box model , Statistical properties of linear regression Analysis of variance , Determine model adequacy, Statistical inferences based on multivariate linear regression models , Weighted least squares

Nonlinear Regression Analysis:Linearization through data transformation, nonlinear regression, Statistical analysis of nonlinear, regression, Determine model adequacy, Statistical inferences based on nonlinear regression models, Linear versus nonlinear regression

Design of Experiments: Strategies for experimentation, Single factor experiments, Two-level factorial experiments, Fractional factorial design, multiple level factorial experiments, Analysis of variance, Interpretation of results from experiments

Selected Advanced Topics :Response surface methods for optimal experimentation decision making, Statistical quality Control, Introduction to control monitoring charts Laboratory exercises includes Computational Experiment & Pilot-scale Experiments (laboratory experiments on linear and nonlinear regression analysis)

References:

1. Montgomery D.C., *Design and Analysis of Experiments*, 8th edition, Wiley, 2012.
2. Montgomery D.C. and Runger G.C., *Applied Statistics and Probability for Engineers*.1994.
3. Box G.E.P., Hunter W.G. and Hunter J.S., *Statistics for Experimenters*, John Wiley & Sons, 1978.
4. An electronic textbook on Statistics is available at the following website. This site is an excellent source of information and learning aids in basic statistics: http://www.statsoft.com/textbook/stathome.html

CHE 5012 SOLID WASTE MANAGEMENT [4 0 0 4]

Solid Waste – A consequence of life, evolution of solid waste management, engineering principles, generation of solid waste, onsite handling, storage and processing, collection of solid waste, transfer and transport, processing techniques and equipment, recovery of resources, conversion products and energy, disposal of solid waste including sanitary land fill, composting, in cineration and pyrolysis, hazarders waste, management issues, planning, choices in onsite handling storage and processing, collection alternatives, transfer and transport options, dispersal options, planning, development, selection and implementation, Land fill design exercises.

References:

1. Tchobanoglous, G., *Integrated Solid Waste Management*, (2e), McGraw Hill New York – 2001.
2. LaGrega, Mi, Buckingham P., and Evans, J., *Hazardous Waste Management*, (2e), McGraw Hill, 2001
3. McBean E., Rovers F. and Farquhar G., *Solid Waste landfill Engineering and Design* (1e), PHI, New York, 1995.

CHE 5013 UPSTREAM AND DOWNSTREAM BIOPROCESSING [3 1 0 4]

Substrate processing, Sterilization of air and medium, development of inocula for industrial fermentation and the aseptic inoculation of plant fermenters. Characteristics of bioseparations, Removal of insolubles: Filtration and micro filtration, Centrifugation, Cell disruption methods. Isolation: Extraction, batch, staged operation, differential extractions and fractional extractions, Adsorption. Product purification: Chromatography, scale-up of chromatography, precipitation, ultrafiltration and electrophoresis. Polishing: crystallization, and drying. Waste disposal and biosafety.

References:

1. Belter P. A., Cussler E. L and Hu W-S, *Bioseparations, Downstream processing for biotechnology*, (1e), John Wiley and Sons. 1988
2. Pauline M. D., *Bioprocess engineering principles*, (1e), Academic press. 1995
3. Rehm H.J. and Reed G., Stephanopoulos G., Biotechnology, (2e), *Bio Processing*, Vol. 3, John Wiley, 1993.
4. Stanbury P.F., Whitakar A. and Hall S.J., *Principles of Fermentation Technology*, Elsevier Publishers, (2e), 2005.

OPEN ELECTIVES

CHE 5051 ADVANCED SEPARATION PROCESSES [2 1 0 3]

Thermodynamics of separation operations-Energy entropy and availability balances-Review of ideal gas and ideal solution Models-Non ideal thermodynamic property Models, P-V-T – equations of state, Models of activity coefficients-Margules-Van Laar. Wilson-NRTL UNI QUAC and UNI FAC Models Liquid-liquid equilibra, Review of equilibrium based methods for binary systems. Equilibrium based methods for Multi component Absorption stripping Distillation and Extraction. Equation tearing procedures-Simultaneous correction procedures Inside out methods, Enhanced Distillation and super critical Extraction – Residue curve Maps-Heterogeneous Azeotropic Distillation, Reactive Distillation – usage of software Super critical fluid extraction – Rate Based Models for Distillation – Thermodynamic properties and transport rate expressions – Methods of calculation – Multi component batch distillation Rapid Solution Methods – Membrane separations Dialysis and Electrodialysis. Adsorption, ion exchange and chromatography.

References:

1. Seader J.D and Ernest J.H. *Separation process principles,* (2e), John Wiley & Sons, Inc – 2006.
2. Wanket P.C., *Separation Process Engg*., (2e), PHC, NJ 2007.
3. Judson C. K., *Separation Processes*, (1e), TMH, New Delhi 1974

CHE 5052 GREEN PROCESSES [3 0 0 3]

Introduction: Definition, the twelve basic principles of green chemistry. Green synthetic methods: Microwave synthesis, electro-organic synthesis, The design and development of environmentally friendly chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes. Materials for green chemistry and technology: Catalysis, environmental friendly catalysts, Bio-catalysis, biodegradable polymers, alternative solvents, ionic liquids Bio-energy: Thermo-chemical conversion: direct combustion, gasification, pyrolysis and liquefaction; Biochemical conversion: anaerobic digestion, alcohol production from biomass; Chemical conversion process: hydrolysis and hydrogenation; Biophotolysis: Hydrogen generation from algae biological pathways; Storage and transportation; Applications

References:

1. Mikami K., *Green Reaction Media in Organic Synthesis*, Wiley-Blackwell 2005.
2. Koichi T., *Solvent-free Organic Synthesis Green chemistry*, Wiley-VCH; 2003
3. Maartje F. K. and Thierry M., *Supercritical Carbon Dioxide: in Polymer Reaction Engineering Green Chemistry*, Wiley VCH 2005
4. Alvise P., Fulvio Z., and Pietro T., *Methods and Reagents for Green Chemistry: An Introduction*, Wiley Inter science 2007
5. Lancaster M,*Green Chemistry*, RSC 2002
6. Stanely E. Manahan, *Green Chemistry and the Ten Commandments of Sustainability*, ChemChar 2005
7. David T. A. and David R. S., *Green Engineering: Environmentally conscious Design of Chemical Processes,* Prentice Hall PTR 2001
8. Roger A. S., Isabel A., and Hanefeld U., *Green Chemistry and Catalysis* , Wiley VCH, 2007
9. James V. B., *Heat Conduction Using Green's Function* (Series in Computational and Physical Processes in Mechanics and Thermal Sciences) Taylor & Francis, 1992

Department of Civil Engineering

Civil Engineering Department was established in the year 1957 with the inception of Manipal Institute of Technology. In 63 years of its glorious existence, the Civil Engineering Department has evolved into one of the most matured and full-fledged departments in the Institute.

The course curriculum has been designed aptly to cater the ever expanding demands of research and industry, by zealously congregating the views of all stake holders. The department upholds excellent interaction with reputed academics in specialized areas, and also with industry professionals at national and international levels.

The department has created a platform for exchanging the research ideas by organizing National level conferences, workshops, seminars from time to time. The department ardently fosters the industry-academia collaborations by conducting invited lectures by eminent industry professionals. Department has got accreditation by National Board of Accreditation in the year 2001 for a period of 5 years and in the year 2008 for a period of 3 years, in 2016 for a period of 3 years and an extension for 3 more years in 2019.

Programs offered

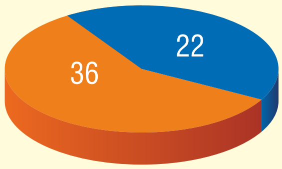
Under Graduate Program
- B.Tech in Civil Engineering (1957)

Post Graduate Programs
- M.Tech in Construction Engineering and Management (1989)
- M.Tech in Structural Engineering (1992)
- M.Tech in Environmental Engineering (2010)
- MSc in Geology (2015)

PhD

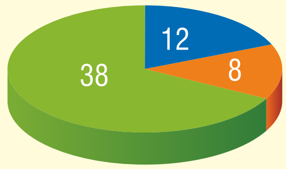
Faculty Strength

Qualification-wise



- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors

DEPARTMENT OF CIVIL ENGINEERING, MIT Manipal

M.Tech. CONSTRUCTION ENGINEERING AND MANAGEMENT

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5153	Statistics, Probability and Reliability	3	1	0	4	CIE 5253	Construction Contracts Management	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CIE 5254	Construction Economics and Accounting	3	1	0	4
	CIE 5155	Construction Management Information Systems	3	1	0	4	CIE ****	Elective I	3	1	0	4
	CIE 5156	Construction Methods and Equipment	3	1	0	4	CIE ****	Elective II	3	1	0	4
	CIE 5157	Construction Engineering Project and Safety Management	3	1	0	4	CIE ****	Elective III	3	1	0	4
	CIE 5158	Operations Research and Decision Theory	3	1	0	4	*** ****	Open Elective	3	0	0	3
	CIE 5161	Project Management Lab – I	0	0	6	2	CIE 5261	Construction Materials Quality Control Lab	0	0	3	1
							CIE 5262	Construction Project Quality Practice Lab	0	0	3	1
							CIE 5268	Project Management Lab - II	0	0	3	1
		Total	**16**	**5**	**9**	**24**		**Total**	**18**	**5**	**9**	**26**
	THIRD AND FOURTH SEMESTER											
II	CIE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CIE 5001	Construction Materials Management	CIE 5007	Organizational Behaviour and Human Resource Management
CIE 5002	Construction Quality Management	CIE 5008	Recent Advances in Concrete Technology
CIE 5003	Construction Risk Management	CIE 5009	Supply Chain Management
CIE 5004	Functional Planning Services Management	CIE 5010	Valuation Techniques in Engineering
CIE 5005	Maintenance and Rehabilitation of Structures	CIE 5011	Value Engineering
CIE 5006	Management by Values		

OPEN ELECTIVES			
CIE 5051	Advanced Strength of Materials	CIE 5053	Non - Destructive Testing of Materials
CIE 5052	Energy and Environment		

SEMESTER I

MAT 5153 STATISTICS, PROBABILITY AND RELIABILITY [3 1 0 4]

Basics of Statistics: Random Variables and its properties..Preliminary analysis of data by graphical representation, Measure of central tendency. Variables, Co-relation, Co-relation Coefficient and it's significance. Basic Probability : Probability of discrete and Continuous variables. Applications of Frequency distribution and probability in analyzing data related to process and quality control. Goodness of fit tests. Monte-Carlo Simulation. Reliability Analysis: Concept of Reliability, Risk and Safety factors. Safety Margin function, Reliability Index. FOSM method of Reliability Analysis. Application of FOSM to Linear and Non Linear Safety Margin Functions.

References:

1. Blank Leland, (1982), "Stastical Procedure for Engineering, Management and Science", Mc-Graw Hill (Series in Industrial Engineering and Management Science).
2. Ang and Tang, (1984), "Probability concepts in engineering planning and design", Vol. I and II, Wiley International.
3. Kottegoda N.T., Rosso Renzo, (1998), "Statistics, Probability and Reliability for Civil and Environmental Engineers", Mc-Graw Hill International.
4. Wackerly D. D., Mendenhall W., and Scheaffer R. L.,(2008) "Mathematical Statistics with applications",7th Edition, Thomson(Brooks/Cole).
5. Ramachandran K. M. , Tsokos C.P.,(2009) " Mathematical Statistics with applications", Academic Press.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

CIE 5155 CONSTRUCTION MANAGEMENT INFORMATION SYSTEMS [3 1 0 4]

Management: Definition, functions, levels. Role of Decision making in Management functions. Herbert-Simon Model of Decision Making. Role of Information in Decision Making Information: Definition, Characteristics, Types, Value; Case Examples of Construction Project Management System: Definition, Description, Types of systems, Decoupling and Control of Systems, Stress in systems. Methodology of System formulation. Case examples in Construction Project Management Prototyping: Definition, Types, Case Examples in Construction Project Management Database, DBMS: Database-Meaning, Types. DBMS- Necessity, Objective, Components. Transaction Processing Systems: Meaning of Transaction Processing, Necessity, Transaction Processing Life Cycle, Case examples in Construction Project Management Introduction to Building Information System Modeling: Meaning, Types, Application in Construction Project Management

References:

1. Gordan Davis B., (1989) "Management Information Systems. Conceptually foundation, Structure and Development", McGraw Hill Book Company, International Edition.
2. Parker Charles S., (1989) "Management Information Systems: Strategy and Action", McGraw Hill Publication Company.
3. Sadgopan S., (1998) "Management Information Systems", Prentice Hall India Ltd., New Delhi.
4. Murdick Robert C., Ross Joel E., (1990) "Management Information Systems for Modern Management", Prentice Hall India Ltd., New Delhi
5. Scott George C., (1986) "Principles of Management Information Systems", McGraw Hill Book Company, International Students Limited

CIE 5156 CONSTRUCTION METHODS AND EQUIPMENT [3 1 0 4]

Conventional and modern methods of construction of building elements, different stages of construction, types of form works, elements of precasting and prefabricated construction, use of prestressing. General data on mechanized construction equipments. Construction equipments and their characteristics, performance and application to the building process. Excavating and Earthmoving equipments and their performance. Drilling, Blasting & Processing equipments. Asphalt and concrete plants & Equipments.

References:

1. Mahesh Varma, (1987), "Construction Equipment and its Planning and Application" Metropolitan Book Co.(P) Ltd.
2. R. L. Peurifoy, W. B. Ledbeffe, (1985), "Construction Planning, Equipment and Methods", McGraw Hill Book Company.
3. James F. Russell, (1985), "Construction Equipment" Reston Publishing Company, Inc.
4. Prof. S. S. Ataev, (1985), "Construction Technology" Mir Publishers Moscow.
5. M. Antill and Paul W.S. Ryan, (1982), "Civil Engineering Construction" McGraw Hill Book Co ; Sydney.

CIE 5157 CONSTRUCTION ENGINEERING PROJECT AND SAFETY MANAGEMENT [3 1 0 4]

Construction Projects- Concept, Project Categories, Characteristic of projects, Project life cycle phase, Project Feasibility Reports, Project planning, Scheduling, Pert Network: CPM Network (A-O-A Network)-

Calculation of floats, Precedence network, Time Cost Relationship, Allocation of resources, Project Control Methodology: Project updating using CPM network. Construction Safety - meaning and Scope, Current Situation in Safety of Construction. Construction Safety - Safety clauses in contract document, Fire prevention and Control, Role of various parties on Construction Safety Management, Safety remedies for common hazards, Safety in Use of Construction equipments, Human Factors in Construction Safety management, Motivation on Safety in construction..

References:

1. Tenah Kwaku A./Gvevara lose M., (1985), "Fundamentals of construction management & organization", Rertan publishing Co. Inc.
2. Raina V.K., (1988), "Construction Management practice", Tata – McGraw Hill publishing co. Ltd.
3. George 1. Ritz, (1994), "Total Construction Project Management", McGraw - Hill Inc.
4. Seetharaman. S., (1997), "Construction Engg. and Management", Umesh Publication.
5. Vaid K. N.,(1988) "Construction Safety Management" National Institute of Construction management, Mumbai.

CIE 5158 OPERATIONS RESEARCH AND DECISION THEORY [3 1 0 4]

Introduction Operation Research. Decision Theory: Decision strategies, Formulation of Decision criteria, Decision trees. Game Theory: Classification of games. Solution to 2 x 2, 2 x n and m x n pay - off matrix:- Graphical, algebraic and linear programming methods.Linear Programming: Formulation, general and standard forms of LPP, dual of LPPs. Solution methods. Transportation Models: Introduction, Methods of finding initial and optimal solution. Assignment Models: Introduction and Solution. Dynamic Programming: Introduction, solution of Discrete DPP, Solution of LPP by Dynamic Programming. Network Analysis: Minimum Span Problems, Shortest- Route problems, Maximal- Flow Problems. Queuing Theory/Waiting Line Theory: General structure of a queuing system – operating characteristics of queuing system, Waiting line models, Post optimality analysis.

References:

1. Bronson Richard, (1983) Theory and Problem of operations Research Schaum's outline series, McGraw Hill Book Co,
2. Hamdy Taha A., (1989) Operations Research: An Introduction, Maxwell Macmillan International Edition, IV Edition
3. Shenoy G.V., Srivastav U.K., Sharma S.C. (1988) Operations Research for Management - Wiley Eastern Limited
4. Gupta M.P., Sharma J.K. (1987) Operations Research for Management National Publishing House, II Edition
5. Mcclain John O. and Thomas Joseph (1987) Operations Management Prentice Hall of India Private Limited, New Delhi

CIE 5161 PROJECT MANAGEMENT LAB-1 [0 0 6 2]

Planning of Construction Projects- Work Break Down Structure, Estimation and Costing, Project Scheduling, Project Monitoring - Exercise through Example Projects and Practical Site Studies.

References:

1. Raina V. K., (1988), "Construction Management practice", Tata – McGraw Hill publishing co. Ltd.
2. Punmia B.C. and Khandelwal K.K., (1989), "Project Planning and Control with PERT. and CPM", Laxmi Publication II Edn..
3. K K Chitkara, (1999), "Construction Project Management", Tata- McGraw Hill publishing co. Ltd.Publication.
4. AICTE Continuing Education Programme, "Quantitative Methods in Construction Management"

SEMESTER II

CIE 5253 CONSTRUCTION CONTRACTS MANAGEMENT [3 1 0 4]

Introduction to contracts: Definitions, Essentials, Salient features, Discharging and Documents for an Engineering Contract; Classification and Applicability of of the various types of contracts. Tendering process: Definitions, List of Documents, Preparation and its submission, Receipt, Evaluation and Award of contract. Issues in tendering process. Administration/Performance of contract: Responsibilities, Monitoring and Quality control/assurance, Settlement of claims Breach of contract: Definition and Classification, Common Breaches. Dispute resolution: General Methods for dispute resolution, Arbitration and Adjudication by courts. Conciliation, Dispute Resolution Boards. Arbitration Process. International contracts / contracts with international funding: International Competitive Bidding and Applicable Law and Settlement of Disputes, International Arbitration.

References:

1. Prakash V. A.,(1997) "Contracts Management in Civil Engineering Projects", NICMAR
2. Patil B. S.,(2009) "Civil Engineering Contracts and Estimates", University Press.
3. John G. Betty(1993/ Latest Edition) "Engineering Contracts", McGraw Hills.
4. Vasavada B. J.,(1997) " Engineering Contracts and Arbitration", (Self Publication by Jyoti B.` Vasavada).
5. Vaid K. N., (1998)"Global perspective on International Construction Contracting Technology and Project Management", NICMAR, Mumbai.

CIE 5254 CONSTRUCTION ECONOMICS AND ACCOUNTING [3 1 0 4]

Economics:Industrial Development - Matters related to Construction Industry- Market Demand and Supply - Theory of Production – Economics of Scale- Cost Concepts - Theory of Costs and Break Even Analysis - Its importance- Contracts. Financial Accounting : Journal, Ledger, Trial Balance and Bank Reconciliation Statement. Preparation of financial statements Its nature, importance and interpretation. Management Accounting: Techniques or Tools of Management Accounting - Comparative and Common sized Balance sheet - Ratio analysis. Financial Management: Investment evaluation- capital budgeting, Budgets and Budgetary Control. Business finance: Source of finance - short term and long term – Working Capital. Accounting through computers

References:

1. Varshney R L, Maheswari K. L., (2005), 'Managerial Economics', Sultan Chanda and Sons, New Delhi.
2. H. L. Ahuja, (2005), 'Business Economics', S. Chand and Co., New Delhi.
3. M. C. Shukla and T.S. Grewal, (2002), 'Advanced Accounts', S.Chand and Co., New Delhi.
4. Pandey LM., (1998), 'financial Management', Vikas Publishing House, New Delhi.
5. Khan M. Y., and Jain P.K., (1992) 'financial Management', Tata McGraw Hill, New Delhi.

CIE 5261 CONSTRUCTION MATERIALS QUALITY CONTROL LABORATORY [0 0 3 1]

Concrete mix design, Tests on fiber reinforced concrete, Tests on concrete with different binders, Tests related to self compacting concrete, Pretensioning System, Non destructive tests, Corrosion tests.

References

1. Raju N Krishna, (2004) "Design of concrete mixes", CBS Publishers, New Delhi.
2. Gahlot P S, "Concrete mix design", Indian society for technical education, Mysore.
3. Krishnamurthy S , Bhattacharjee B, "Concrete mix design and recent technology of placing concrete", Indian society for technical education, Mysore.
4. Kishore Kaushal, (1992) "Method of concrete mix design with chemical admixtures and for pumped concrete", Standard Publishers, Delhi.
5. Rathore Shailendra Singh, (2003) "Computer aided concrete mix design", Allied Publishers Delhi.

CIE-5262 CONSTRUCTION PROJECT QUALITY PRACTICE LABORATORY [0 0 3 1]

Case Studies of Construction Project Standard Operating Procedures (SOP), Project Quality Assurance(QA) Models, Exercises of SOP and QA Site Visits to ongoing Construction Projects.

References:

1. Constructions Operations Manual of Policies and Procedures, Sidney M .Levy, Andrew.M. Civetello, McGrahill Educations, 2016.
2. Standard Operating Procedure Manuals of Construction Organizations
3. Quality Assurance Manuals of Construction Organizations

CIE 5268 PROJECT MANAGEMENT LAB-2 [0 0 3 1]

Introduction to Project Management Softwares- MS Project & Primavera. Working on Practical Projects

References:

1. Project Planning and Control using Oracle Primavera P6, Paul Harris, Eastwood Harris Pty Ltd., Victoria, Australia, 2018
2. Construction Scheduling with Primavera P6, Jongpil Nam, AuthorHouse UK Pvt.Ltd., Bloomington, USA,2016
3. Project Planning and Control using Microsoft Project, Paul Harris, Eastwood Harris Pty Ltd., Victoria, Australia, 2018
4. Construction Scheduling with Microsoft Project, Jongpil Nam, AuthorHouse UK Pvt.Ltd., Bloomington, USA,2016
5. Reference Manuals

SEMESTER III and IV

CIE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CIE 5001 CONSTRUCTION MATERIALS MANAGEMENT [3 1 0 4]

Integrated material Management: Meaning, Functions, and Advantages. Selective Control, Codification and Standardization. Material planning and budgeting, Material requirement Planning. : Objectives, Functions, Purchase Systems, Price forecasting, Purchasing strategies under fluctuating Prices, Purchasing Capital equipment. Source selection.Stores an d Inventory management: Principles and Practice, Different inventory costs, Static risk model, EOQ, Practical systems, - P and Q systems, Probability based inventory control, Just In Time inventory method, Introduction to Value Stream Mapping and Supply Chain Management.

References:

1. Gopal Krishnanan P., Sundaresan M., (2010) "Material Management Integrated Approach", Prentice Hall India, New Delhi.
2. Datta A.K., (2010) "Material Management and Inventory Control: Principles and Practice", Jaico Publishing House, Bombay.
3. Shah N.M., (2000) "Integrated Concept of Material Management", Tata Mc Graw Hill.
4. Michael R. Leenders, Fearn, (1977) "Purchasing and Material Management", D.B. Tarporevale Sons and Co., Bangalore.
5. Zipkin, Paul H., (2000) "Foundations of Inventory Management", McGraw Hill International

CIE 5002 CONSTRUCTION QUALITY MANAGEMENT [3 1 0 4]

Foundations of Total Quality Management: Understanding quality, TQM philosophy: Concept of Deming, Juran, Crosby, Imai, Ishikawa, Taguchi, Shingo philosophies. Models and frame works. TQM Tools: An overview of Flowcharts, Check sheets, Histogram, Cause and effect diagrams, Pareto diagram, Scatter diagram and Control charts. Planning: Policy, Strategy and goal deployment, Partnership and resources, Design for quality. Performance: Measurement frame works, Self-assessment audit and review, benchmarking. Process management, Redesign, Quality management system, Quality assurance.

People: Human resource management(Introduction only), Cultural change, Innovation and learning, Leadership and commitment. Implementing TQM: TQM and management of change, Planning and implementation of TQM, Sustained improvement, TQM models in practice.ISO 9000 quality systems, Six sigma practice. Customer-Supplier Chain, Continuous improvement. ISO 14001 quality systems.

References:

1. Oakland John S (2006) " TQM", Text with cases, Butterworth-Heinemann, Oxford.
2. Zairi Mohamed, (1992) "Total Quality Management For Engineers", Aditya Books, NewDelhi.
3. Feigenbaum Armand V., (1991) "Total Quality Control", McGraw Hill Inter- national Edition.
4. Dalela Suresh, Saurabh, (1997) "ISO-9000 A Manual for Total Quality Management", S.Chand, NewDelhi.
5. Woodside Gayle, Aurrichio Patrick (2000) " ISO 14001,Auditing manual" Mc-graw Hill, New Delhi.

CIE 5003 CONSTRUCTION RISK MANAGEMENT [3 1 0 4]

Project Risk Management Definition, Role of Project Risk Management in Project Management, Good Risk Management Practice, Critical Success Factors for Project Risk Management, Definiation of Risk, Individual Risks and Over all project Risks, Stake holders Risk Attitude, Responsibility for Project Risk Management, Project Manager's Role, Project Risk Management Process, Critical Success Factors, Barriers, Tools, Documentation Process, Qualitative Risk Analysis, Risk Responses, Monitoring and Controlling Risks.

References:

1. Flanagan Roger, Norman George, 'Risk Management and Construction', Blackwel Science Ltd., Oxford, 1999
2. Chapman Robert J., 'The Rules of Project Risk Management: Implementation Guide lines for Major Projects', Routledge, London, 2014
3. Revere John J., 'Construction Risk: A Guide line to Identification and Mitigation of Construction Risks', Marketing Technologies, London, 2003
4. Meyer Christian, Quell Peter, 'Risk Model Validation', Risk Books, London, 2016
5. Smith Nigel J., Merena Tony, Jobling Paul, ' Managing Risks in Construction Projects', Willey Blackwell, Network.

CIE 5004 FUNCTIONAL PLANNING SERVICES MANAGEMENT [3 1 0 4]

Components of urban forms and their planning, Concepts of neighborhood unit, Street system and layout in a neighborhood. Functional planning buildings: Optimization of space, Spatial Synthesis graphical techniques, heuristic procedures. Space requirements and relationships for typical buildings, like residential offices, hospitals, etc. Standard fire, fire resistance, classification of buildings, means of escape, alarms, etc.

Engineering services in a building as a systems. Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems. Building Maintenance: Scheduled and contingency maintenance planning. Maintenance standards. Economic maintenance decisions. Environmental factors: Thermal performance of buildings; Comfort factors and measurements; climatic design; Solar control and shading devices, Louver design, ventilation. Introduction to lighting: units of light, colour lamps, luminaries, Daylight design of general lighting schemes; Energy management and lighting; acoustical design of auditoria and noise control in buildings.

References:

1. Chiara Joseph, Koppellman Lee, (1975) 'Urban planning and design criteria', Van Nostrand Reinhold, New York.
2. Catanese Anthony J , Snyder James C, (1979) 'Introduction to urban planning', MGH, NewYork.
3. Building Services Research Information Association, (1987) 'Building services material hand book', E and FN Span, London.
4. Chadderton David V, (1991) 'Building services engineering', E and FN Span, London.
5. Watson Lee, (1990) 'Lighting design handbook', Mc Graw Hill, New York.

CIE 5005 MAINTENANCE AND REHABILITATION OF STRUCTURES [3 1 0 4]

Performance of construction materials and components in services; Causes of deterioration; preventive measurements and maintenance; principles of assessment of weathering and durability.

Deterioration process in concrete structures, Construction and design defects. Diagnostic methods, Load testing and nondestructive testing. Causes and prevention of cracks in masonry structures, Corrosion in structures, process and prevention, Fire damage of buildings. Repair materials, cement aggregate, polymer and construction chemicals. Management of concrete for durability. Damage assessment and restoration techniques, case studies of restoration works, buildings, bridges, water retaining structures, marine structures.

Special repairs, maintenance inspection and planning, Budgeting and management.

References:

1. Emmons Peter H, (2001) 'Concrete Repair and Maintenance illustrated', Galgotia Publications Pvt. Ltd., New Delhi.
2. Allen R.T.L., Edwards S. C., (1987) 'The Repair of Concrete Structures', Blackie & Sons Ltd., Glasgow, London.
3. Peter H Emmons,(200 l), "Concrete Repair and Maintenance Illustrated', Galgotia Publications Pvt. Ltd., New Delhi.
4. Allen R.T.L ., Edwards S. C., (1987)'The Repair of Concrete Structures', Blackie & Sons Ltd., Glasgow, London.

CIE 5006 MANAGEMENT BY VALUES [3 1 0 4]

Values for Indian Managers. Anatomy of ethico-moral management from self to SELF: The ascent from pettiness to dignity. Appraisal of Management by value programmes. Socio-Cultural change and managers travails. Social values and Individual attitudes, Work ethic. India's vision of Humanism. Heirarchism as Organisational Value. Rediscovering Indian Psychology for Managers. Leadership modeling. Mental health of a manager.

References:

1. Chakraborty S.K., (1991) "Management by Values: Towards Cultural congruence", Oxford University Press, New Delhi.
2. Chakraborty S.K., (1987) "Managerial Effectiveness and Quality of Work life: Indian Insights", Tata-McGraw Hill.
3. Monappa A., (1972) "Ethical Attitudes of Indian Managers", All India Management Association.

CIE 5007 ORGANIZATIONAL BEHAVIOUR & HUMAN RESOURCE MANAGEMENT [3 1 0 4]

Organizational Behaviour: Nature of organizational behaviour: Defininition key elements, scope, model. Stages of evolution of OB, Researches in OB. Foundations of Individual Behaviour: Personality, Perception, Learning Attitudes, Values and Job satisfaction, Concepts of motivation. Foundations of Group Behaviour: Small groups in an organization, Leadership, Power and Politics, Communication, Conflict. Organization: Organization culture, work stress, organizational changes and development. Human Resource Management: Definition, Scope, Objectives' HR Planning Job Analysis and Design. Recruitment, Selection, Placement, Training Performance appraisal, Employee remuneration and Benefits. Industrial relations: Trade unions, Disputes and their resolution.

References

1. Aswathappa A., (2000) "Organizational Behaviour: Texts and cases Himalaya Publishing House, Mumbai.
2. Hersey Paul, Kenneth Blanchard H., "Management of Organizational Behaviour: Utilising Human Resources", Prentice Hall India Ltd. Edition, New Delhi.
3. Davis Keith, "Human Behaviour at work: Organizational Behavior", Tata-McGraw Hill, New Delhi.

4. Suri S.K. (1988) "Human Resource Development and Productivity: New Perspective", National Productivity Council, Delhi.
5. Rao Subba P, (1999) Essential of HRM and Industrial Relations, "Text cases and Games", Himalaya Publishing house, II Edition.

CIE 5008 RECENT ADVANCES IN CONCRETE TECHNOLOGY [3 1 0 4]

Introduction to Recent Advances in Concrete & Review of Conventional/Normal Concrete: Merits and Demerits of concrete, Features of Recent Advances in Concrete, Types of Concrete related tests, Production and use of concrete. High Performance Concretes: Classification, general properties, Advantages, Disadvantages, Applications, Description of types, Guidelines for Mix design and use of following concretes:

Light weight concrete, High strength concrete, Ultra-high strength concrete (reactive powder concrete), High workability concrete/Self compacting concrete, Fiber reinforced concrete, Polymer-concrete composites. Special Concretes: General properties, Advantages, Disadvantages, Applications, Concreting practices, Guidelines for Mix design and use of -Heavy weight concrete, Shrinkage compensating concrete, Mass concrete, Roller compacted concrete. Durability of Concrete: Deterioration processes – Physical, Chemical, Environmental & Biological; Measures for ensuring durability, Corrosion of reinforcing steel, protective measures. Testing and Quality Control of Concrete: Classification of test methods, In-situ, Non-Destructive & Partially–Destructive tests for fresh concrete, hardened concrete and durability of concrete.

References:

1. P. Kumar Mehta And Paulo J. M. Moteiro, (2005), "Concrete – Micro Structure, Properties and Materials", Indian Concrete Institute, Chennai and Prentice Hall & Mc Graw-Hill in USA.
2. Neville A. M. And Brooks J. J, (2000), "Concrete Technology", Addison Wesley Longman Ltd.
3. M. L. Gambhir, (2008/ Latest Edition), "Concrete Technology"
4. M. S. Shetty, (2009 / Latest Edition), "Concrete Technology"

CIE 5009 SUPPLY CHAIN MANAGEMENT [3 1 0 4]

Supply chain, Objectives, importance, ,decision phases , supply chain enablers. Achieving strategic fit and scope, performance measures, drivers and measures. Transportation and Strategies. Network design and Optimization. Supply chain in Inventory management, Bull-Whip effect. Green Supply chain.

References:

1. Supply Chain management- Strategy, Planning and Operation" Sunil Chopra, Peter Meindel – Fifth Edition, Pearson- Prentice Hall
2. Supply chain – Text and cases, Janat shah, Pearson publication
3. Green Supply Chains- An action manifesto, Stuart Emmet and Vivek Sood, Wiley Publication.
4. ERP demystified, Alexis Leon, Tata Mcgraw- Hill education private limited, second edition

CIE 5010 VALUATION TECHNIQUES IN ENGINEERING [3 1 0 4]

Purpose of valuation, Different forms of values, Outgoings: Municipal & Govt. Taxes, insurance, Loss of rent, collection charges, sinking fund, Annual repairs & maintenance. Depreciation. Methods of calculation of depreciation., Year's Purchase, Capitalized value, Obsolescence, Amortization. Methods of valuation: Open land valuation, Factors affecting intrinsic values of land, Comparative method, Abstractive method, Belting method. Rent: Definition, Forms of rents. Cost of structure, BIS rules for measuring plinth area and cubical contents. Valuation of land with buildings: Rental method, Land and building method, Valuation on profit basis, Direct comparison of capital value, Residual or Development method. Valuation of agricultural/farm lands, Rights and Liabilities of Lessor & Lessee, Leasehold properties, freehold Properties. Easements : Self-imposed, Legally created, Dominant and Servient heritage Effect of easements on valuation. Market : Real Estate market and market value, fair market value, open market value , affecting parameters

References:

1. Banerjee D.N (1998) " Principles and Practice of Valuation ". Eastern law house
2. Roshan H. Namavathi,(2001) "Professional Practice " Lakhani Book Depot.
3. Mitra A.K., (1986)"Theory and Practice of Valuation " Eastern law house
4. Rao Gopinath C H,(2002) "Valuation Practices of Immovable Properties." Edition 12, Publisher, C H Gopinath Rao, Chennai.
5. Tedkay, (l992)'Asserssment and Renovation of Concrete Structures', Longman Scientific & Technical, Harlow, England.

CIE 5011 VALUE ENGINEERING [3 1 0 4]

Introduction and background of value Engineering. Hurdles in value Engineering. Value Engineering Job Plan. Functional Analysis. Creative thinking, Cost modeling, Life cycle costing, Project work, Worksheets, Guidelines, Checklists. Value Engineering Case studies.

References:

1. Zimmerman Larry W., Hart Glen P., (1988) "Value Engineering", CBS Publishers, New Delhi.
2. Iyer S.S., (1996) "Value Engineering", New Age International.
3. Krishnan P., Saxena K.R., (1995) "Value Engineering in Project Management", Oxford and IBH.
4. Vittal M.S., (1993) "Value Engineering", System Consultancy Service, Bangalore.
5. AICTE, "Value Engineering", New-Delhi, 1990.

OPEN ELECTIVES

CIE 5051 ADVANCED STRENGTH OF MATERIALS [3 0 0 3]

Torsion: Torsion of non-circular and thin walled sections. Unsymmetrical bending of straight beams, thin walled beam cross sections - shear centre for thin walled sections.

Bending of curved beams: crane hooks, closed rings - correction factor for flanged cross sections. Bending of beams curved in plan. Beams on Elastic foundation.

References:

1. Srinath L. S , Advanced Solid Mechanics TMH., New Delhi.
2. Boresi A. P., and Sidebottom O. M., Advanced Mechanics of Materials, John Wiley and sons in N.Y.
3. Den Hartog, Advanced Strength of Materials, McGraw Hill, N.Y.

CIE 5052 ENERGY AND ENVIRONMENT [3 0 0 3]

Introduction: Energy consumption, crisis, Policies, Laws and Principles. Renewable sources of energy and Environmental aspects: example: solar energy, Hydro power, etc Non-renewable sources of energy and Environmental aspects –, coal, oil, natural gas.Global and regional impacts of Climate change: Greenhouse effects, global warming and Acid rain

References:

1. G.D.Rai. “Non-Conventional energy sources” Khanna publishers.
2. D P Kothari, et.al., “Renewable energy sources and Emerging Technologies”.
3. Wilber L.C. "Hand book of Energy Systems" Engg Wiley & Sons 1989.
4. Rao and Parulekar B.B. Energy Technology- Non-conventional Renewable & Conventional, Second Edition Khanna Publication 1977.

CIE 5053 NON- DESTRUCTIVE TESTING OF MATERIALS [3 0 0 3]

Introduction, Liquid Penetrant Tests, Magnetic particle testing, Acoustic Emission Test, Ultrasonic test, Electromagnetic Testing Method, Leak Testing Methods, Radiographic Testing Method.

References

1. Barry Hull & Vernon John, Non-destructive Testing, 1st edition, Macmillan, London, 1988.
2. R. Halmshaw, Non-destructive Testing, 2nd edition, Edward Arnold, London, 1991.
3. McGonnagle W. J., Non-destructive testing, Gordon & Beach Science, New York, 1983.

DEPARTMENT OF CIVIL ENGINEERING, MIT Manipal

M.Tech. STRUCTURAL ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5154	Optimization Techniques	4	0	0	4	CIE 5271	Design of Pre-Stressed Concrete Structures	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CIE 5272	Earthquake Resistant Design of Structures	3	1	0	4
	CIE 5171	Advanced Mechanics of Solids	3	1	0	4	CIE ****	Elective I	3	1	0	4
	CIE 5172	Analysis and Design of Tall Structures	3	1	0	4	CIE ****	Elective II	3	1	0	4
	CIE 5173	Finite Element Method	3	1	0	4	CIE ****	Elective III	3	1	0	4
	CIE 5174	Structural Dynamics	3	1	0	4	*** ****	Open Elective	3	0	0	3
	CIE 5162	Computational and Structural Engineering Lab	0	0	6	2	CIE 5264	Computer Application Lab	0	0	6	2
							CIE 5265	Professional Practice in Structural Engineering	0	0	3	1
		Total	**17**	**4**	**9**	**24**		**Total**	**18**	**5**	**9**	**26**
	THIRD AND FOURTH SEMESTER											
II	CIE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CIE 5012	Advanced Design of RCC Structures	CIE 5018	Design of Precast Concrete Structures
CIE 5013	Advanced Design of Steel Structures	CIE 5019	Masonry Structures
CIE 5014	Advanced Foundation Engineering	CIE 5020	Offshore Structural Engineering
CIE 5015	Analysis, Design and Construction of Shell Structures	CIE 5021	Reliability Analysis and Design of Structures
CIE 5016	Applications of Finite Element Method for Structural Engineering	CIE 5022	Soil Structure Interactions
CIE 5017	Design of Bridges and Flyovers	CIE 5023	Structural Stability

OPEN ELECTIVES			
CIE 5051	Advanced Strength of Materials	CIE 5053	Non - Destructive Testing of Materials
CIE 5052	Energy and Environment		

SEMESTER I

MAT 5154 OPTIMIZATION TECHNIQUES [4 0 0 4]

Solution of Eigen Value Problems: Forward and inverse, Simultaneous iterations, Jacobi. Method of Regression: Linear and non-linear regression - Application to Structural Engg.

Introduction to optimization: Engineering applications of optimization, classification of optimization problems. Classical Optimization Techniques: Single variable, multivariable optimization with and without constraints. Kuhn-Tucker conditions. Linear programming - Standard form of LP problems, graphical methods. Linear and Non-Linear Programming: One dimensional minimization, Elimination methods, Interpolation methods, unconstrained optimization techniques, direct search methods, Descent methods, constrained optimization, Direct and indirect methods.

References:

1. Rao S.S: Optimization: theory and Practice, Wiley Eastern Limited (2005).
2. Fox, R.L: Optimization methods for Engineering Design, Addison - Wesley, reading mass (1971).
3. Arora, J.S: Introduction to optimum Design McGraw Hill International editions, N.Y (1989).
4. Goldberg, D.E: Genetic algorithms in search, optimization, and Machine learning, Addison Wesley, Reading Mass (2001).
5. Deb, K: Optimization for Engineering Design, Algorithms and examples Prentice - Hall of India private Ltd., New Delhi (2002).

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar: Research Methodology: A Step-by-Step Guide for Beginners, SAGE, (2005).
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger: Essentials of Research Design and Methodology, John Wiley & Sons, (2004).
3. John W. Creswel: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, (2004).
4. Donald R Cooper & Pamela S Schindler: Business Research Methods, McGraw Hill International, (2007).
5. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin: The Research Imagination, Cambridge University press, (2007).

CIE 5171 ADVANCED MECHANICS OF SOLIDS [3 1 0 4]

Theory of Elasticity in rectangular and polar co-ordinates – equilibrium equations, stress strain relations, compatibility equations, principal stresses and strains, Airy's stress function. Theory of rectangular and circular plates – slopes and curvatures, strain displacement relations, moment curvature relations, differential equations of plates, bending of plates. Theory of Shells – membrane and bending action of shells, stress resultants and strain curvature relations, analysis of simple shells.

References:

1. Stephen P. Timoshenko and J.N. Goodier: Theory of Elasticity, Edn 3, Auckland: McGraw Hill Book Company (2008).
2. L.S. Srinath: Advanced Mechanics of Solids, Tata McGraw Hill, Delhi (2009).
3. A.C. Ugural: Plates and Shells: theory and analysis, Fourth Edition, Boca Raton: CRC Press, Taylor & Francis Group (2018).
4. K. Chandrashekhara: Analysis of Thin Concrete Shells, 2nd Revised Edition, New Age International Publishers, New Delhi (2008).

CIE 5172 ANALYSIS AND DESIGN OF TALL STRUCTURES [3 1 0 4]

Introduction to analysis and design of Tall structures: Design criteria: Design philosophy, Loadings, IS 16700-2018 code provisions. Materials: High performance concrete and high strength steel. Structural planning and structural forms for tall buildings, floor systems. Foundations for Tall structure: Raft and pile foundation general principles. Approximate analysis of different form of tall structures to Lateral loads. Chimneys/Hollow shafts subjected to lateral loads, foundations, transmission line towers.

References:

1. Bungale S. Taranath: Structural Analysis and Design of Tall Buildings, McGraw
2. Byran Statford Smith and Alex Coull: Tall building structures
3. IS 16700 Criteria for structural safety of tall concrete buildings (latest)

CIE 5173 FINITE ELEMENT METHOD [3 1 0 4]

Theory of elasticity, plane stress and plane strain problems, concept of an element, types of elements, displacement models, shape functions, minimization of potential energy approach, application of boundary conditions, application of finite element method to analyze pin jointed and rigid jointed structures, natural co-ordinates, application to plane stress and plane strain problems.

References:

1. Desai C.S. and Abel J.E: Introduction to the Finite element method, CBS publications, New Delhi, 1st Indian edition (1987).
2. Cook R.D., Malkas D.S. and Plesha, M.E: Concepts and Applications of Finite Element Analysis, Third Edition John Wiley and Sons, New York (1980).
3. Bathe K.J: Finite element procedures in Engineering Analysis, Edn 3, Prentice Hall Engle Wood, Cliffs, NJ (1997).
4. Zinkiewicez O.C: The Finite element method, Edn 3, Tata McGraw Hill Book Co, New Delhi, III Edition (1979).

CIE 5174 STRUCTURAL DYNAMICS [3 1 0 4]

Types of dynamic problems. Formulation of equations of motion. Free Vibration of SDOF system. Forced vibrations of SDOF system subjected to harmonic excitation and general dynamic loading. Free and forced vibration (Harmonic and impulse loads only) of MDOF structure. Raleigh's method, improved Raleigh's method, Dunkerley's method, matrix iteration method. Continuous Systems: Free longitudinal vibration of bars, flexural vibration of single span beams, forced vibration of beams.

References:

1. Chopra A.K: Dynamics of structures – Theory and application to Earthquake Engg. Prentice - Hall of India Pvt. Ltd. New Delhi (2001).
2. Paz. M: Structural Dynamics, Edn 2, C.B.S. Publishers and Distributors, New Delhi (2004).
3. Mukhopadhay: Vibrations of structures and structural systems, Oxford and IBH, New Delhi (2000).
4. Clough and Penzien: Dynamics of structures – McGraw Hill publications (1993).

CIE 5162 COMPUTATIONAL AND STRUCTURAL ENGINEERING LAB [0 0 6 2]

Developing Computer Program for analysis of axially loaded bar, plane trusses, space trusses, plane rigid frames and continuous beams. Concrete mix design by IS Code and other methods. Study on flexural behavior of reinforced concrete, pre-stressed rectangular concrete beams. Non-destructive tests on concrete. Experimental study on models for verification of Maxwell's reciprocal Theorem Experimental study and analysis on models of Two hinged arch, Cantilever beams, Fixed beams. To study Influence Line diagram in frames and beams using Muller Breslau's principle.

References:

1. IS:10262 Indian Standard recommended guidelines for concrete mix design (latest)
2. SP: 23 Hand book of Concrete mixes (latest)
3. Lin T.Y., Burns N.H: Design of Prestressed Concrete Structures, Edn III, John Woley and Sons, New York.II SEMESTER

SEMESTER II

CIE 5271 DESIGN OF PRE-STRESSED CONCRETE STRUCUTRES [3 1 0 4]

Introduction, Code Provisions, Loses, Analysis of Type1 & Type2 members under Flexure at Transfer and at Service, Analysis for Ultimate Strength, Limiting Zone, Magnel's Graphical Method, Design of Sections for Tpye 1 & type 2 flexure members, Limit State of Collapse for Shear & Torsion, Calculation of Deflection, Crack Width, Transmission of Prestress. Analysis of Continuous Beams: Moment due to Reactions, Pressure Line due to Prestressing Force, Principle of Linear Transformation, Concordant Tendon Profile, Tendon Profiles, Analysis for Ultimate Strength, Moment Redistribution. Analysis & Design of Composite Sections, Design of One-way Slabs, Compression Members, Circular Prestressing members: Prestressed Concrete Pipes.

References:

1. IS:1343 Indian Standard code of practice for pre-stressed concrete (Latest).
2. IS:1785 Indian Standard Specification for plain hard drawn steel for pre-stressed concrete (Latest).
3. IS 784 Pre-stressed concrete pipes- specification (latest).
4. N Krishnraju: Pre-stressed concrete, Edn III, Tata McGraw Hill publications, New Delhi.
5. T Y Lin, N H Burns: Design of pre-stressed concrete structures, Edn III, John Wiley & sons, publications, New York.

CIE 5272 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES [3 1 0 4]

Importance of earthquake resistant design. Types of seismic waves. Earthquake intensity, modified Mercalli scale. Response to ground acceleration, response analysis by mode superposition, response spectrum analysis, earthquake response of in-elastic structures. Codal provisions. Design criteria for multi-storey buildings, elevated structures like: elevated tanks and stack like structures.

References:

1. Duggal S. K: Earthquake Resistant Design of Structures, Oxford University Press, New Delhi.
2. Pankaj Agarwal and Manish Shrikhande: Earthquake resistant Design of structures, Prentice Hall of India Pvt. Ltd. New Delhi.
3. Jaikrishna: Elements of Earthquake Engineering, South Asia Publishers, New Delhi.
4. IS:1893- Indian Standard Criteria for Earthquake Resistant Design of Structures, (Latest).

CIE 5264 COMPUTER APPLICATION LAB [0 0 6 2]

Introduction to Software packages and analysis of plane truss, plane frame, grid floor and space frame subjected to various types of static and dynamic loading and their combinations as per Indian standards. Mini project related to structural Engineering structure.

References:

1. Relevant software reference Manual.

SEMESTER III and IV

CIE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

CIE 5265 PROFESSIONAL PRACTICE IN STRUCTURAL ENGINEERING [0 0 3 1]

Roles and Responsibilities, Professional Conduct, Qualities and Qualifications, Challenges of practicing, Essential Handbooks and Library. Principles of Structural Engineering. Concepts. Practical Loads and Materials: Common Materials, Availability, Suitability Concrete, Steel, Aluminium Composites. Practical Analysis, Design and Detailing of Structures: Suitability of Structural Systems. Thumb rules, Approximate Methods for review of results, Essentials of Drawings, Specifications, Bill of Quantities. Essentials of Implementation: Field Skills, Risks, Law, Accreditations and licenses, Civil and Criminal Implications in Practice, Agreements, Disputes, Arbitration, Ethical Practices, Social Responsibility, Continuing Professional Development, Association, Professional Bodies

References:

1. KG Krishnamurthy & SV Ravindra: Professional Practice- PHI Learning
2. KL Hansen & KE Zenobia: Civil Engineer's Handbook of Professional Practice- ASCE Press
3. KK Humphreys - Marce Dekker: What Every Engineer Should know about Enthics –New York
4. Risk Management in Civil, Mechanical & Structural Engineering- Edited by M James- Thomas Telford

PROGRAM ELECTIVES

CIE 5012 ADVANCED DESIGN OF RCC STRUCUTRES [3 1 0 4]

Analysis and Design of continuous beams, multi-storey frames, bunkers and silos, overhead water tanks: Rectangular and Intze type water tanks, Design of deck and beams of T beam deck Slab Bridge. Pre-fabricated construction: Requirements for pre-fabricated R.C. members – design and erection of pre-fabricated members – general erection principles – transportation and storage – joints in pre-fabricated structures – analysis and design of embedded parts.

References:

1. A.H. Nilson and G Winter: Design of Concrete Structures, McGraw Hill Publishing Company, Singapore.
2. N. Krishna Raju: Advanced Reinforced Concrete Design, Edn II, CBS Publishers, New Delhi.
3. Cook John: Composite Construction, John Wiley and sons New York.
4. Relevant Indian standards

CIE 5013 ADVANCED DESIGN OF STEEL STRUCUTRES [3 1 0 4]

Limit state method of design of steel frames. Design of members subjected to combined forces. Design of steel plate girder bridge. Design of tubular Trusses and scaffoldings using circular hollow, rectangular hollow. Design of Transmission towers. Design of Pre-engineered Buildings Design of Composite beams and columns.

References:

1. Beedle, L.S: Plastic design of steel structures, John Wiley, N.Y.
2. Segvi Willian T: LRFD steel design, PWS publishing company, Boston.
3. Nethercot: Limit state, design of structural steel work, Chapman and Hall.
4. Relevant Indian Standard codes.

CIE 5014 ADVANCED FOUNDATION ENGINEERING [3 1 0 4]

Shallow foundation: Design of combined footings, and mats by conventional method. Pile foundations: Types, Pile capacity by dynamic & Static formula, Analysis of piles. resistance by wave equation, Pile load tests, settlement of single pile – Elastic solutions – Well foundations: Forces acting on well foundation, analysis of well foundation using Terzaghi's method. Machine foundations: Machine foundations – Type of machine foundations – Methods of analysis of machine foundation. Foundations for tall structures, special foundations: hyperbolic parabolic shells etc.

References:

1. Joseph E. Bowles: Foundation Analysis and Design, Second Edition – McGRAW Hill Book Co.
2. Winterkorn and Fang: Foundation Engineering Hand Book – Van Nostrand Reinhold.
3. Relevant IS codes

CIE 5015 ANALYSIS, DESIGN AND CONSTRUCTION OF SHELL STRUCTURES [3 1 0 4]

Classification of Shells, Properties of curves, Membrane Theory, Beam Theory, Cylindrical shells, Bending Theory, North light shells. Membrane Theory for shells of revolution -Domes, Paraboloids, Conical shell, Rotational Hyperboloids. Synclastic shells – Elliptic paraboloids. Anticlastic shells – Hyperbolic paraboloid – umbrella roof. Conoids - Folded plates. Construction of concrete shell roofs.

References:

1. Ramaswamy, G.S: Design and Construction of shell roofs, CBS Publications, New Delhi (1999).
2. Timoshenko and Krieger: Theory of Plates and Shells, McGraw Hill, New York (1959).
3. Ugural, A.C: Stresses in Plates and Shells, McGraw Hill, New York (1999).

CIE 5016 APLLICATIONS OF FINITE ELEMENT METHOD FOR STRUCTURAL ENGINEERING [3 1 0 4]

Application of finite element method - for three dimensional analyses, for the analysis of plates, for dynamic analysis of pin and rigid jointed structures, for non-linear analysis, for elastic stability problems, for soil - structure interaction analysis, memory management techniques

References:

1. Desai C.S. and Abel J.E: Introduction to the Finite element method, CBS publications, New Delhi, 1st Indian edition (1987).
2. Cook R.D., Malkas D.S. and Plesha, M.E: Concepts and Applications of Finite Element Analysis, Third Edition John Wiley and Sons, New York (1980).
3. Bathe K.J: Finite element procedures in Engineering Analysis, Prentice Hall Engle Wood, Cliffs, NJ, III Edition (1997).
4. Zinkiewicz O.C: The Finite element method, Third edition, Tata McGraw Hill Book Co, New Delhi, III Edition (1979).

CIE 5017 DESIGN OF BRIDGES AND FLYOVERS [3 1 0 4]

Introduction: Historic Developments-Importance of Bridges, Classifications-Steps involved in Bridge Projects- Typical forms of Reinforced Concrete Bridges. Limit State Method of Design of Bridges: Basis of Design as per IRC, Design of Deck Slabs, Design of Solid Slab Culverts. T- Beam Bridges: Analysis and Design, Detailing of Longitudinal Beam, Balanced Cantilever Bridge, Grade Separators: Flyovers, Under Passes, Forms and Parts, Analysis Design of Single Cell Box Type Under Passes, Analysis and Design of Single Bay Portal Type Under Passes- IRC SP 90- IRC -54. Sub-Structures and Foundations: Bearings, -Stability Analysis of Piers and Abutments, Foundations.

References:

1. Johnson Victor: Essentials of Bridge Engineering.
2. Jagadeesh & Jayaram: Design of Bridge Structures - PHI Learning
3. IRC-6- Standard Specifications and Code of Practice for Road Bridges- Section II - Loads & Stresses - Indian Roads Congress
4. IRC-112- Code of Practice for Concrete Bridges- Indian Roads Congress
5. IRC-78 - Standard Specifications and Code of Practice for Road Bridges- Section VII - Foundations and Substructures - Indian Roads Congress

CIE 5018 DESIGN OF PRECAST CONCRETE STRUCTURES [3 1 0 4]

Introduction: Suitability of precast construction, Preliminary Design Consideration, General Design Principles. Precast Frame Analysis: Types of Precast Construction, Precast Concrete Beams: Column and Shear Wall, Horizontal Floor Diaphragm: Shear Transfer Mechanism, Edge Profile and Tie Steel Details. Joint and Connections: Definitions, Basic Mechanism, Compression and Tension Joint, Pinned Jointed, Moment Resistance Connection, Ties in Precast Concrete Structures. Design of precast truss elements and purlins.

References:

1. Kim S. Elliott: Precast Concrete Structures, Butterworth- Heinemann, An imprint of Elsevier Science, www.bh.com, (2002).
2. FIP Planning and Design Handbook on Precast Building Structures, Published by SETO Ltd (1994).
3. Hubert Bachmann & Alfred Steinle: Precast Concrete Structures, Published by Ernst &Sohn GmbH & Co. KG (2011).

CIE 5019 MASONRY STRUCTURES [3 1 0 4]

Material properties, masonry units; Masonry in compression, prism strength, eccentric loading, kern distance; Masonry under lateral loads, in-plane and out-plane loads, analysis of perforated shear walls, lateral force distribution for flexible and rigid diaphragms; cyclic loading, ductility of masonry walls for seismic design, infill masonry; Structural design of masonry, working and ultimate strength design, strengthening of existing masonry structures.

References:

1. Hendry, A.W., Sinha B.P and Davies S.R: Design of Masonry Structures, E and F.N. Span, London.
2. Paulay T, Priestley M. J. N: Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, INC.
3. IS:13828 Improving Earthquake Resistance of Low Strength Masonry Buildings Guidelines (Latest).

CIE 5020 OFFSHORE STRUCTURAL ENGINEERING [3 1 0 4]

Introduction to Offshore Structural Engineering: types of offshore structures, construction aspects. Environmental loadings: Morison equation approach for wave force piles. Foundation analysis: pile axial and lateral load capacity and its response, bearing capacity of footings and its response, settlement of foundations. Dynamic analysis of offshore structure Fatigue analysis and examination for dynamic effects.

References:

1. Dawson: Offshore structural Engineering, Prentice Hall.
2. Design and Construction of Offshore Structures, Institution of Civil Engineers (ICE), London, (1977).

CIE 5021 RELIABILITY ANALYSIS AND DESIGN OF STRUCTURES [3 1 0 4]

Concepts of structural safety, statistics and probability. Statistical properties of concrete, Steel, Brick and Mortar. Characterization of variables. Probabilistic analysis of gravity and wind loads, Monte Carlo-simulation. Basic concept of structural systems: System reliability, modeling of structural systems, bounds on system reliability. Automatic generation of mechanisms. Application to RCC, PSC and Steel structures.

References:

1. Ranganathan R: Reliability Analysis and Design of Structures, Tata - McGraw Hill Company Ltd., New Delhi.
2. Ang and Tang: Probability concepts in Engineering Planning and Design, Vol. I and II, John Wiley and Sons, New York.
3. Kapoor R.C: Reliability in Engineering designs, John Wiley and sons, New York.

CIE 5022 SOIL-STRUCTURE INTERACTION [3 1 0 4]

Soil-Foundation Interaction. Soil response model, Elasto-plastic behaviour, Time dependent behaviour. Beams on Elastic foundations, Analysis of beams of finite length. Plates on elastic medium, Infinite plates, thin and thick plates. Elastic analysis of piles, Analysis of pile groups, Interaction analysis.

References:

1. A.P.S. Selvadurai: Elastic Analysis of Soil-Foundation Interaction.
2. H.G. Poulos and E.H. Devis: Pile-Foundation Analysis and Design, John Wiley & Sons.
3. R.F. Scott: Soil Mechanics and Engineering, McGraw Hill.

CIE 5023 STRUCTURAL STABILITY [3 1 0 4]

Buckling of columns, lateral buckling of beams, beam - columns and frames: buckling of simple frames. Elastic buckling of plates and shells, failure of cylindrical shells. dynamic stability of structures, code specifications for design for the design of columns, beam columns, beams and stiffeners in girders.

References:

1. Timoshenko and Gere: Stability of structures, McGraw Hill, New Delhi.
2. Chajes: Principles of structural stability theory, Prentice Hall, Englewood cliffs, New Jersey.
3. Iyengar, N.G.R: Structural stability of columns and plates, East-west Press, New Delhi.

OPEN ELECTIVES

CIE 5051 ADVANCED STRENGTH OF MATERIALS [3 0 0 3]

Torsion: Torsion of non-circular and thin walled sections. Unsymmetrical bending of straight beams, thin walled beam cross sections - shear centre for thin walled sections. Bending of curved beams: crane hooks, closed rings - correction factor for flanged cross sections. Bending of beams curved in plan. Beams on Elastic foundation.

References:

1. Srinath L.S: Advanced Solid Mechanics TMH., New Delhi.
2. Boresi A.P., and Sidebottom O.M: Advanced Mechanics of Materials, John Wiley and sons in N.Y.
3. Den Hartog: Advanced Strength of Materials, McGraw Hill, N.Y.

CIE 5052 ENERGY AND ENVIRONMENT [3 0 0 3]

Introduction: Energy consumption, crisis, Policies, Laws and Principles. Renewable sources of energy and Environmental aspects: example: solar energy, Hydro power, etc. Non-renewable sources of energy and Environmental aspects – coal, oil, natural gas. Global and regional impacts of Climate change: Greenhouse effects, global warming and Acid rain

References:

1. G.D.Rai: Non-Conventional energy sources, Khanna publishers.
2. D P Kothari, et.al.: Renewable energy sources and Emerging Technologies.
3. Wilber L.C: Hand book of Energy Systems, Engg Wiley and Sons (1989).
4. Rao and Parulekar B.B: Energy Technology- Non-Conventional Renewable and Conventional, Second Edition Khanna Publication (1977).

CIE 5053 NON- DESTRUCTIVE TESTING OF MATERIALS [3 0 0 3]

Introduction, Liquid Penetrant Tests, Magnetic particle testing, Acoustic Emission Test, Ultrasonic test, Electromagnetic Testing Method, Leak Testing Methods, Radiographic Testing Method.

References:

1. Barry Hull & Vernon John: Non-destructive Testing, 1st edition, Macmillan, London, (1988).
2. R. Halmshaw: Non-destructive Testing, 2nd edition, Edward Arnold, London, (1991).
3. McGonnagle W. J: Non-destructive testing, Gordon & Beach Science, New York, (1983).

DEPARTMENT OF CIVIL ENGINEERING, MIT Manipal

M.Tech. ENVIRONMENTAL ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5160	Computational Methods and Optimization Techniques	3	1	0	4	CIE 5284	Ecology and Environmental Impact Assessment	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CIE 5285	Industrial Waste Water Treatment	3	1	0	4
	CIE 5181	Advanced Water and Waste Water Treatment	3	1	0	4	CIE ****	Elective I	3	1	0	4
	CIE 5182	Air and Noise Environment	3	1	0	4	CIE ****	Elective II	3	1	0	4
	CIE 5183	Applied Environmental Chemistry and Microbiology	3	1	0	4	CIE ****	Elective III	3	1	0	4
	CIE 5184	Solid and Hazardous Waste Management	3	1	0	4	*** ****	Open Elective	3	0	0	3
	CIE 5163	Advanced Environmental Engineering Lab	0	0	6	2	CIE 5266	Computer Applications in Environmental Engineering Lab	0	0	6	2
							CIE 5267	Environmental Engineering Applications Lab	0	0	3	1
		Total	**16**	**5**	**9**	**24**		**Total**	**18**	**5**	**9**	**26**
	THIRD AND FOURTH SEMESTER											
II	CIE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CIE 5024	Disaster Management	CIE 5029	Membrane Process for Water and Waste Water Treatment
CIE 5025	Earth and Environment	CIE 5030	Occupational Safety and Health
CIE 5026	Environmental Management	CIE 5031	Remote Sensing and GIS in Environmental Engineering
CIE 5027	Environmental Quality and Pollution Monitoring Techniques	CIE 5032	Transport Processes and Modeling of Aquatic Systems
CIE 5028	Green Technology		

OPEN ELECTIVES			
CIE 5051	Advanced Strength of Materials	CIE 5053	Non - Destructive Testing of Materials
CIE 5052	Energy and Environment		

SEMESTER I

MAT 5160 COMPUTATIONAL METHODS AND OPTIMIZATION TECHNIQUES [3 1 0 4]

Statistics and Probability, frequency, characteristics, central tendency and dispersion, concepts of Probability, binomial, poison and normal distribution, applications, analysis problems using Computer Programming, numerical methods and solutions of partial differential equations, finite difference method, Optimization significance, problems and multivariable optimization, Linear programming and solutions of standard, pivotal, simplex methods, numerical search methods for 1-D non – linear, quadratic and cubic interpolation methods.

Reference Books:

1. Antony Raiston Philip Rabinowitz - A First Course in Numerical Analysis. Dover Publications; Second edition (2001)
2. Brice, Luther N.A. and James O. Wilkes - Applied Numerical Methods. Krieger Pub Co (1990)
3. Rao. S.S. – Optimization, John Wiley & Sons, 2009
4. Sienkiowics O.C. - The Finite Element Method
5. Statistical Hydrology

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo& David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

CIE 5181 ADVANCED WATER AND WASTEWATER TREATMENT [3 1 0 4]

Water Quality and treatment, Physical, chemical and biological parameters of water, standards, indices, water purification systems, Unit operations and unit processes both for water and wastewater treatment, Overview of biological wastewater treatment, objectives, biological treatment processes, aerobic and anaerobic treatment processes for waste water.

References:

1. MetCalf and Eddy. Waste water Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill
2. Peavy,H.s, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill.
3. Weber, W.J. Physicochemical Processes for Water Quality COlltrol, John Wiley.

CIE 5182 AIR AND NOISE ENVIRONMENT [3 1 0 4]

Air Pollution significance, sources, classification and characteristics of air pollutants, chemical and photochemical reactions, meteorological variables, lapse rate, inversions, stability conditions, general characteristics of stack plumes, stack height, Gaussian dispersion equation, ambient and stack sampling, analysis and control, global effects of air pollution,air quality, emission standards, air pollution act, legislations and index, noisepollution, significance, sources, effets, measurement, control mesures and legislations.

References:

1. Rao H.V.N. and Rao M.N, (1989), "Air pollution", Tata Mc Graw Hill, New Delhi.
2. Rao C.S., (1995), "Environmental Pollution control", Wiley Eastern Ltd. Delhi.
3. Wark Kenneth and Wamer C.F, "Air Pollution its Origin and Control". Pearson; 3 edition (1997)
4. Sincero. A. P.andSincero G.A; "Environmental Engineering". Prentice Hall.
5. Air Pollution - Sampling and Analysis - APHA.

CIE 5183 APPLIED ENVIRONMENTAL CHEMISTRY & MICROBIOLOGY [3 1 0 4]

Basic concepts from general chemistry, qualitative chemistry, quantities chemistry, physical chemistry, colloid chemistry, biochemistry, radio chemistry. Instrumental methods of analysis. Environmental biochemistry – proteins, carbohydrates, lipids, enzymes, nucleic acid, metabolic processes. Chemical toxicology, coagulation and water softening. Microbiology – scope and introduction, characterization, classification and identification of microorganisms, pure cultures and cultural characteristics, enzymes and their regulations, microbial metabolism, control of microorganisms.

References:

1. Sawyer, C.L. McCarty P.L. and Parkin, G.F., Chemistry for Environmental Engineering, McGraw-hill, (2003)
2. Pelezar, M.J., Chan E.C.S and Hrieg, N.R., Microbiology, Tata McGraw Hill, (1986)
3. Julia Levy, Campbell, J.J.R and Henry Blackburn, T, Introductory Microbiology, John Wiley & Sons, 1973
4. Benefield, L.D. and Randall C.W., Biological processes design for waste water, Prentice Hall, 1980
5. Metcalf and Eddy. Inc., Waste water Engg. Treatment, disposal reuse, Tata McGraw Hill Publishing Company Ltd., New Delhi, (2002).

CIE 5184 SOLID AND HAZARDOUS WASTE MANAGEMENT [3 1 0 4]

Introduction to Solid waste, Hazardous waste, legal frame work, Cradle to grave concept, Waste manifest system. Waste generation Collection and transportation: Solid waste generation, Methods to estimate waste quantities, Material recovery facility collection rate, collection routes optimization, transfer station, Method and means of transportation. Processing and recycling, energy recovery system. Hazardous waste treatment, physicochemical process, Disposal Methods, control and treatment of landfill gases and leachates, Land fill operations. Siting of wastes management facilities: Site Remediation, the hazardous system and the national priority list. Remedial Action, Radio Active Wastes treatment

References:

1. Integrated Solid Waste Management – George Tchobanaglous, Hilary Theisen and Samuel A. Vigil, (1993),
2. Environmental Engineering – A Design Approach Sincero, A.P., and Sincero, G.A., (1999), Prentice Hall of India Pvt. Ltd., New Delhi.
3. Solid Waste Engineering – Vesiland, A, Thompson Books.
4. Solid Waste Management – CPHEEO Manual
5. Hazardous Waste Management- Wentz C.A., McGraw Hill, 1989.

CIE 5163 ADVANCED ENVIRONMENTAL ENGINEERING LABORATORY [0 0 6 2]

Determination of physical, chemical and bacteriological characteristics, coagulation, chlorination, heavy metal, colour, adsorption studies, pilot scale studies, demonstration and study of various instruments used for analysis of water and waste water analysis.

References:

1. American Public Health Association et al. 'Standard Methods for the Examinations of Water and Waste Water' APHA.
2. Aneja, K.R. 'Experiments in Microbiology, Plant Pathology and Tissue Culture'. WishwaPrakashan, New Delhi.
3. Manualof methods of General Bacteriology, ASM Publication.

SEMESTER II

CIE 5281 ECOLOGY AND ENVIRONMENTAL IMPACT ASSESSMENT [3 1 0 4]

Ecology classification, terminology, sub-divisions, structure and functions of ecosystems, energy flow, primary production, ecological succession, population and habitat ecology, biochemical cycles, aquatic and terrestrial ecosystems, eutrophication, Environmental Impact Assessment significance and need, EIS, FONSI, procedure for conducting EIA, conceptual framework, Impact assessment methodologies of EIA, assessment and prediction of impacts on environmental attributes, public participation, IAA, REIA, EIA for development projects.

References:

1. Odum - Fundamentals of Ecology - Saunders, 1967.
2. Kormondy- Conceptsof Ecology- Printcehall publication, 1965.
3. Anantakrishnaan, T.N - Bio-resourcesEcology- Oxfordand IBH Publishing Co., 1989.
4. Krebs J. - Ecology - The experimental analysis of distribution and abundance-II Edition Harper international, 1972.
5. Canter L - Environmental Impact Assessment McGraw Hill 1977.
6. Mall C.A.S. and Day J.W - Ecosystem modeling in theory and practice: An introduction with case NI stories - John Willey.

CIE 5282 INDUSTRIAL WASTEWATER TREATMENT [3 1 0 4]

Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effluent standards and receiving water quality standards. Different aspects and choices of various alternatives. Industrial Waste Survey-Process flow charts, condition of waste stream. Material balance. Pretreatment of Industrial Wastewater – Wastewater Treatment in specific industries: Distillery, Sugar, Pulp and paper, Cement, Textile, Dairy, Fertilizer, Pesticides, Pharmaceutical, Ultimate disposal of Industrial Wastewater, effects of waste additions on physical and chemical properties of soil, Bio-Remediation of Distillery, Sugar, Refinery and Diary Industries. Design of complete treatment system disposal for industries

References:

1. Nelson N Nemerow – "Liquid Waste of industry theories, "Practices and Treatment. Addison Willey New York.
2. Nardam S Azad – "Industrial Wastewater Management Hand Book" McGraw Hill book Co., Newyork.
3. Dickinson - Practical Waste Treatment and Disposal Applied Science publication, London.
4. Self N.J – Industrial pollution Control.
5. Gaynor W Dawson, et al – "Hazardous Waste Management"- A Wiley- Interscience Publication, New York.
6. James F parr et al – "Land Treatment of Hazardous Wastes"- Noyes Data Corporation, Parkridge, New Jersey, USA.

CIE 5266 COMPUTER APPLICATIONS IN ENVIRONMENTAL ENGINEERING LABORATORY [0 0 6 2]

C++ programming language, Input, output and logical statements; iterative loops, Programming of environmental management problems such as population forecasting, physical and chemical characteristics, Streeter Phelps equation, stack height, screens, aeration tank, sedimentation tank, sand filters, sewer.

Use of packages in Environmental Engineering.

References:

1. Balaguruswamy E., (2006) 'Object Oriented Programming with C++', Tata McGraw Hill, New Delhi.
2. Ang and Tang, (1984) "Probability concepts in engineering planning and design", Vol. I and II, Wiley International.
3. Kottegoda N.T., Rosso Renzo, (1998) "Statistics, Probability and Reliability for Civil and Environmental Engineers", Mc-Graw Hill International.
4. AICTE Continuing Education Programme, "Quantitative Methods in Construction Management"

CIE 5267 ENVIRONMENTAL ENGINEERING APPLICATIONS LABORATORY [0 0 3 1]

Sampling and analysis and treatment of water and waste water, ground water quality, ambient and stack sampling of air pollutants and analysis, use of remote sensing and GIS, mini projects related to the areas of water, waste water, ground water, ambient air and using packages related to surface water, ground water, air, remote sensing and GIS.

SEMESTER III and IV

CIE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CIE 5025 EARTH AND ENVIRONMENT [3 1 0 4]

Planet Earth Evolution and constitution, Minerals and Rocks forms, relationship to crystals, rocks and their types, Surface features of the Earth, Landforms, weathering and erosion, Plate tectonics and sea-floor spreading, Economic Geology, Earth hazards, Importance of biodiversity to mankind and its preservation, Natural resources: Renewable and non-renewable resources - Alternatives to fossil fuels , Pollution of air, water and soil and its control- discussion of several case studies, Climate change, Reasons and effects of climate change on the environment, mitigation, geo-engineering techniques.

References:

1. A B Roy (2010) Fundamentals of Geology, Narosa Publishing House, New Delhi
2. Gerard Kiely (2007) Environmental Engineering, Tata McGraw Hill Education Private Ltd., New Delhi

CIE 5031 REMOTE SENSING AND GIS IN ENVIRONMENTAL ENGINEERING [3 1 0 4]

Definition, Basics of Remote sensing, Sensors, Multi spectral scanners, Platforms, Data Acquisition and Interpretation - Visual and digital interpretation, Application of remote sensing techniques.GIS - Concepts, functionality, Data acquisition, processing, storage and retrieval, Hardware and software requirements, GIS and Remote sensing data integration, GIS in Decision support system, Network analysis& applications in Environmental Management.

References:

1. George Joseph , Fundamentals of Remote Sensing Universities Press, Hyderabad 2005
2. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman Remote sensing and image interpretation John Wiley & Sons, 2008 4.
3. Burrogh P.A., Principles of Geographical Information System for Land Resources Assessment, Oxford Publications, 1980
4. Paul A. Longley, Micheal F. Goodchild, David J. Magaine David J. Magaine, David W Rhind. Geographical Information System. Vol. I & II, John wiley& Sons. Inc.,1999
5. M. Anji Reddy, Textbook of Remote Sensing and Geographical Information systems, BS Publications, Hyderabad. 2011.

CIE 5032 TRANSPORT PROCESSES AND MODELING OF AQUATIC SYSTEMS [3 1 0 4]

Rivers, streams and lakes: Derivation of steady state stream equation. 1-D Oxygen balance models - Streeter- Phelp's equation. Calibration and verification of 1-D Oxygen model. Mixing Zones in rivers - definition, steady state 2-D analysis. Dissolved Oxygen models for lakes under completely mixed and stratified conditions. Estuaries; Physical aspects of estuaries. Distribution of water quality in estuaries. Estimation of tidal dispersion coefficient. Derivation of estuary equation.Ground water quality modeling concepts- simplified nutrient loading models for rivers and lakes.

References:

1. Rich L.G. Environmental Systems Engineering McGraw Hill-1972.
2. BiswasA.K. - Models for water quality management- McGraw Hill 1980.
3. Rinaldi S.D.andSoncini, R- Modelling and Control of river water quality McGraw Hill-1979.
4. Gower A.M. - Water quality in catchment ecosystems john wiley- 1980.
5. Thomann and Mueller, 1986. Principles of water quality management and control- Harper and Row pubs.

CIE 5027 ENVIRONMENTAL QUALITY AND POLLUTION MONITORING TECHNIQUES [3 1 0 4]

General principles of sample collection and data analysis. Gravimetric methods for solids analysis in water and wastewater, analysis of common cations and anions in water/wastewater. Titrimetric methods; Electrochemical methods; Spectrophotometric methods;Biological methods and microbiology; Monitoring and analysis of air pollution. Monitoring soil and groundwater pollution

References:

1. Sawyer, C. L. McCarthy, P.L and Parkin, G. F. Chemistry for Environmental Engineering. McGraw-Hill.

CIE 5026 ENVIRONMENTAL MANAGEMENT [3 1 0 4]

Environment and Sustainable Development - carrying capacity, relationship with quality of life, carrying capacity and resource utilization. Environmental Laws and Policies –Water Act, Air Act, Environment Protection Acts, Solid Waste management Rules, Hazardous and Biomedical waste Rules, Related Policies –Importance in Management. Environmental Economics: Introduction, economic tools for evaluation, Cleaner development mechanisms (CDM) and their applications. Environmental Audit – methods, procedure, reporting and case studies. Environmental management system and Techniques – Environmental Safety and ISO 14000 series of standards, ISO 14001 Standards, Environmental Management systems. (EMS) and 18000 series of standards.

References:

1. Lohani B. N (1984)., “Environmental Quality Management”, South Asian Publishers, New Delhi
2. Chanlett, (1973)“Environmental Protection”, McGraw Hill Publication, Newyork.
3. Danoy G.E., and Warner R.F., (1969), “Planning and Design of Engineering Systems”, Unwin Hyman Publications.
4. T. V. Ramachandra & Kulakarni, Environmental management

CIE 5024 DISASTER MANAGEMENT [3 1 0 4]

Principles of Disaster Management, Assessment of Disaster Vulnerability, Preparedness and Mitigation measures for various Disasters, Issues in Environmental Health, Water & Sanitation. Post Disaster Relief & Logistics Management, Emergency Support Functions and their coordination mechanism, Resource & Material Management, Voluntary Agencies & Community Participation at various stages of disaster management, Integration of Rural Development Programmes with disaster reduction and mitigation activities, Role of Remote Sensing, Science & Technology.

References:

1. Savinder Singh Environmental Geography, Prayag Pustak Bhawan, 1997

2. R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000
3. H.K. Gupta (Ed) Disaster Management, Universiters Press, India, 2003
4. R.B. Singh, Space Technology for Disaster Mitigation in India (INCED) University of Tokyo, 1994
5. Dr. Satender , Disaster Management in Hills, Concept Publishing Co., NewDelhi, 2003
6. M.C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001

CIE 5028 GREEN TECHNOLOGY [3 1 0 4]

Green technology, overview to site design: site planning and analysis, market analysis vs. Site analysis, Water and site design: problems and issues with water and site practices, Waste as a resource economics, water and industrial effluent reuse, pisciculture, groundwater recharge of sewage effluents. Health aspects of water reuse - guidelines for evaluating recreational water reuse, resource conservation and recovery act, source reduction and waste minimization, waste to energy, metals recovery

References:

1. Springer, “Recycling and Resource Recovery Engineering”- Springer – Verlag Berlin Heidelberg (1996)
2. ICE: Reuse of Sewage Effluent, Proceedings of the International Symposium, Thomas Felford London (1985)
3. Dean R.B. and E., “Water Reuse Problems and Solutions” Academic Press (1981)
4. Green Building Rating System for New Construction and Major Renovations (LEED-NC), Version 2.2, October 2005, 81 pp.
5. Matthiessen, Lisa Fay, and Morris, Peter, “Costing Green: A Comprehensive Cost Database & Budgeting Methodology”, 2003, 27 pp.
6. Roberts, Don V., “Sustainable Development-A Challenge for the Engineering Profession”, FIDIC Annual Conference, Oslo, Norway, 18 June 1990, 23 pp.

CIE 5029 MEMBRANE PROCESS FOR WATER AND WASTE WATER TREATMENT [3 1 0 4]

Introduction to membrane separation processes, principles and application of Membrane filtration, Reverse osmosis, Nanofiltration, Ultrafiltration, Microfiltration, Membranes and modules, MF/UF experimental set up, Laws of MFIUF, Limiting Phenomena, Economic study, Applications, Case studies.

References:

1. Bailey and Ollis, Biochemical Engineering and Fundamentals, McGraw Hill International, 1986.
2. Smith, Principles of Biochemistry, 7th Edition, McGraw Hill international.
3. Agarwal's A Text book of Biochemistry, Goe\Publishing House, Meerut.
4. P. K. Guptha, Elements of Biotechnology, Restogi Publishers, Meerut. S.
5. American Water Works Association Research Foundation, Water Treatment- membrane processes, Mc. GrawHill.

CIE 5030 OCCUPATIONAL SAFETY AND HEALTH [3 1 0 4]

Occupational safety and Healthact. Occupational Safety and Health Administration, right to know Laws, Accident Causation, Correcting Missing Skills, Investigator Tendencies and Characteristics, Human Error Model, Petersew's Model, Epidemiological Models, Ergonomics at work place, Occupational Hazard and Control - Hazard Analysis, Fault Tree Analysis, Human Error Analysisin Causation with Hazard Analysis, Emergency Response. Hazards and their Control in various industries, Fire prevention and Protection, Technical Requirements of Product Safety Programme, Occupational Health and Safety Considerations, Personal Protective Equipments, Occupational Health and Safety case studies.

References:

1. David L. Goetsch. "Occupational Safety and Health" for Technologists, Engineers and Managers 3Medition. Prentice hall.
2. David. A. Calling - Industrial Safety Management and Technology, Prentice Hall, New Delhi.
3. Della D. E. and Giustina, Safety and Environmental Management. Van Nostrand Reinhold International Thomson Publishing Inc, 1996.
4. Trevethick R. A. Environmental and Industrial Health Hazards, William Heinemann Medical Books Ltd., London (1973).

OPEN ELECTIVES

CIE 5051 ADVANCED STRENGTH OF MATERIALS [3 0 0 3]

Torsion: Torsion of non-circular and thin walled sections. Unsymmetrical bending of straight beams, thin walled beam cross sections - shear centre for thin walled sections.

Bending of curved beams: crane hooks, closed rings - correction factor for flanged cross sections.Bending of beams curved in plan.Beams on Elastic foundation.

References:

1. Srinath L.S ,Advanced Solid Mechanics TMH., New Delhi.
2. Boresi A.P., and Sidebottom O.M.,Advanced Mechanics of Materials, John Wiley and sons in N.Y.
3. Den Hartog, Advanced Strength of Materials, McGraw Hill, N.Y.

CIE 5052 ENERGY AND ENVIRONMENT [3 0 0 3]

Introduction: Energy consumption, crisis, Policies, Laws and Principles. Renewable sources of energy and Environmental aspects: example: solar energy, Hydro power, etc Non-renewable sources of energy and Environmental aspects –, coal, oil, natural gas. Global and regional impacts of Climate change: Greenhouse effects, global warming and Acid rain

References:

1. G.D.Rai. “Non-Conventional energy sources” Khanna publishers.
2. D P Kothari, et.al.,“Renewable energy sources & Emerging Technologies”.
3. Wilber L.C. "Hand book of Energy Systems" Engg Wiley & Sons 1989.
4. Rao and Parulekar B.B. Energy Technology- Non-conventional Renewable & Conventional, Second Edition Khanna Publication 1977.

CIE 5053 NON- DESTRUCTIVE TESTING OF MATERIALS [3 0 0 3]

Introduction, Liquid Penetrant Tests, Magnetic particle testing, Acoustic Emission Test, Ultrasonic test, Electromagnetic Testing Method, Leak Testing Methods, Radiographic Testing Method.

References

1. Barry Hull & Vernon John, Non-destructive Testing, 1st edition, Macmillan, London, 1988.
2. R. Halmshaw, Non-destructive Testing, 2nd edition, Edward Arnold, London, 1991.
3. McGonnagle W. J., Non-destructive testing, Gordon & Beach Science, New York, 1983.

Department of Computer Science and Engineering

The B.Tech. degree program in Computer Science and Engg was started in the year 1985 under the Dept. of Electronics and Communication. The Department of Computer Science & Engineering (CSE) came into existence as an independent department in 1988. Over the years, the department has developed to become a centre of excellence providing in-depth technical knowledge and opportunities for innovation and research with well-equipped computer facilities and dedicated faculty.

The department has tie-up with various industries and offers electives in collaboration with the industries. The department has strong research interest in diverse areas of Computer Science and also offers a Ph.D. Program. Great emphasis is given on the emerging, interdisciplinary, cutting edge areas of research in the department. The focus areas of research are Artificial Intelligence, Pattern Recognition, Deep Learning, Data Analytics & Data Mining, High Performance Computing System, Computer Vision& Machine Learning, Artificial Neural Networks, Software Engineering, Computer Networks, Information Security, IOT, Machine Learning, Natural Language Processing, Model based Analysis, Computer Aided Diagnostics & Assistive Technologies, Biometrics, Web Applications. The research activities of the faculty members and the students have results in more than 450 publications in International Conferences as well as Journals.

Students are encouraged to participate in co-curricular and extracurricular activities. The department coordinates the activities of the student clubs IE(CSE), Linux Users Group and ACM student chapter. Students are placed in reputed industries like Microsoft, AQR Capital, CISCO, CITRIX, Goldman Sachs, SAP Labs, VM Ware, Komprise, Samsung Semiconductors etc.

Programs offered

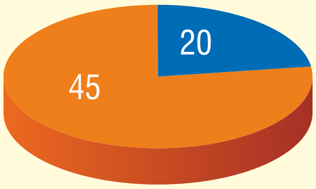
Under Graduate Program
- B.Tech in Computer Science and Engineering (1985)

Post Graduate Programs
- M.Tech in Computer Science and Engineering (1989)
- M.Tech in Computer Science and Information Security (2010)

PhD

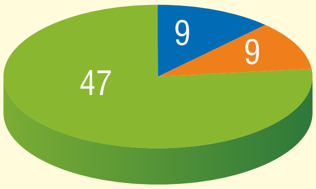
Faculty Strength

Qualification-wise

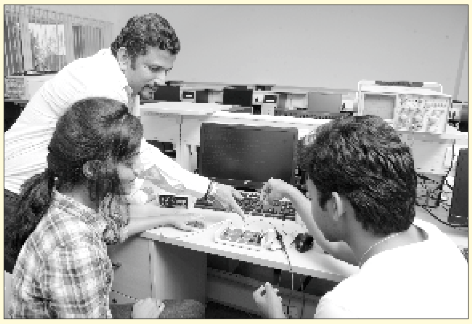


- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, MIT Manipal

M.Tech. COMPUTER SCIENCE AND ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5152	Computational Methods and Stochastic Processes	4	0	0	4	CSE 5253	Advanced Systems Software	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CSE 5254	Fundamentals of Quantum Computing	3	1	0	4
	CSE 5151	Advanced Computer Networks	3	1	0	4	CSE ****	Elective I	4	0	0	4
	CSE 5152	Advanced Data Structures and Algorithms	3	1	0	4	CSE ****	Elective II	4	0	0	4
	CSE 5153	Advanced Database Systems	3	1	0	4	CSE ****	Elective III	4	0	0	4
	CSE 5154	High Performance Computing Systems	3	1	0	4	*** ****	Open Elective	3	0	0	3
	CSE 5161	Computing Lab I	0	0	6	2	CSE 5261	Computing Lab II	0	0	6	2
	CSE 5162	Program Lab	0	0	3	1						
		Total	**17**	**4**	**12**	**25**		**Total**	**21**	**2**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	CSE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CSE 5001	Advanced Computer Graphics	CSE 5007	Embedded Systems
CSE 5002	Algorithmic Foundations of Data Science	CSE 5008	Fundamentals of Theoretical Computer Science
CSE 5003	Object Oriented Systems Design	CSE 5009	Parallel Algorithms
CSE 5004	Logic and Functional Programming	CSE 5010	Natural Language Processing
CSE 5005	Computer Vision and Image Processing	CSE 5011	Web Services
CSE 5006	Pattern Classification	CSE 5012	Advanced Machine Learning

OPEN ELECTIVES			
CSE 5051	Deep Learning	CSE 5052	Software Project Management and Quality Assurance

SEMESTER I

MAT 5152 COMPUTATIONAL METHODS AND STOCHASTIC PROCESSES [4 0 0 4]

Random variables, one and two dimensional random variables, expectation, variance, covariance and correlation coefficient of random variables, uniform distribution, Functions of random variables, Bayesian estimation, credible intervals, Bayesian Hypothesis. Statistics of stochastic processes, Stationarity; Autocorrelation, Power density spectrum. Markov Models, Gaussian mixture models. Data Analysis, Regression, Predicting real value outputs. Optimization Techniques, Mathematical formulation of linear programming problems, Simplex method. Numerical solution to BVP's by finitedifference & finiteelement methods. Solution of parabolic elliptic, hyperbolic PDEs. Linear Algebra, several decompositions and Singular Value decomposition (SVD). Basics of Graph theory, connectivity, spanning tree and traversability. Two person zero sum game theory, non- zero sum game theory. Dominance Method, Graphical Method.

References:

1. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
2. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.
3. Applied Numerical Methods McGraw Hill.
4. HamdyA. Taha – Operations Research McGraw Hill.
5. Frank Harary, Graph Theory, Narosa Publishing House 2001.
6. David C Lay, Linear Algebra and its Applications, Pearson Publications (Third Edition).
7. NarsinghDeo, Graph Theory with Applications to Engg. and Computer Science, PHI Learning Private Ltd

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

The Lab focusses on enabling students to develop experiments, analyze data, think critically about theory and data and communicate their results and analysis in writing and oral presentation.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo& David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain& Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

CSE 5151 ADVANCED COMPUTER NETWORKS [3 1 0 4]

Unmanned aerial vehicle (uav) networks: Introduction, challenges, key issues, comparative study, UAV features, Multi-UAV network, UAV network topologies, categorization, self-organization in UAV networks, UAV routing protocols, Handoffs in UAV networks. SDN: Benefits, Use cases, Controllers, Policies, Overlays, Automating Cloud via SDN. Supporting Multivendor Ecosystems. Data Center Evolution: Modern Data Center, Monolithic Storage Array, Virtualization, Convergence, the Role of Cloud, Cloud Types, Cloud Drivers. Emerging Data Center Trends, Hyperconverged Infrastructure. Multimedia Networking: Types of Multimedia, Streaming, DASH. CDN, Case Studies. VoIP. Best-Effort Service, Jitter, Best-Effort Networks, QoS Guarantees, Resource Reservation, Call Admission. Optical Networks: Multiplexing, Generations, Switching, Transparency. WDM Network Elements: Optical Line Terminals, Amplifiers, Multiplexers, OADM Architectures. Network Survivability: Basic Concepts, Self-Healing rings, Protection, Resilient Packet Rings, Service Classes.

References:

1. Brian Underdahland Gary Kinghorn, “Software Defined Networking For Dummies”, Cisco Special Edition, John Wiley & Sons, Inc., 2015.
2. Scott D. Lowe, James Green, and David Davis, “Building a Modern Data Center: Principles and Strategies of Design”, ActualTech Media, USA, 2016.
3. James F. Kurose, Keith W. Ross, “Computer Networking-A Top Down Approach”, (6e),Pearson, 2013.
4. Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, “Optical Networks -A Practical Perspective”, (3e), Morgan Kaufmann, 2010.

CSE 5152 ADVANCED DATA STRUCTURES AND ALGORITHMS [3 1 0 4]

Amortized Analysis: Aggregate analysis, The Aggregate analysis, The accounting method, The potential method, Dynamic Tables. B-Trees: Basic operations on B-Trees, Deleting a key from a B-Tree. Binomial trees and Binomial heaps: Operations on Binomial heaps. Structure of Fibonacci heaps, Mergeable heap operations, Decreasing a key and deleting a node. The van EmdeRoas Tree: Preliminary approaches, A recursive structure, Disjoint-set operations: Linked-list representation of disjoint sets, Disjoint set forests. Single-Source Shortest Path: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Difference constraints and shortest paths. All-Pairs Shortest Paths: shortest Paths and matrix multiplication, Johnson's algorithm for sparse graphs. Maximum Flow: Flow Networks, The Ford-Fulkerson method, Maximum Bipartite Matching, Multithreaded Algorithms: The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort.

References:

1. Cormen Thomas H., Leiserson Charles E, Rivest Ronald L. and Stein Clifford,"Introduction to Algorithms", (3e), MIT Press, 2009.
2. Cormen Thomas H., Leiserson Charles E, Rivest Ronald L. and Stein Clifford, "Introduction to Algorithms" (2e), Prentice-Hall India, 2001.
3. Baase Sara and Gelder A.V., "Computer Algorithms -Introduction to Design and Analysis", (3e), Pearson Education, 2000
4. Anany Levitin, "Introduction to the Design and Analysis of Algorithms," (3e), Pearson Education, 2011

CSE 5153 ADVANCED DATABASE SYSTEMS [3 1 0 4]

Introduction to Distributed Data Processing, Top-Down Design Process, Distributed Design Issues, Fragmentation, Allocation, Data Directory, Data Access Control, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing Properties of Transactions, Types of Transactions, Serializability Theory, Locking-Based Concurrency Control Algorithm, Timestamp-Based Concurrency Control Algorithm, Dead lock Management, "Relaxed" Concurrency Control, Reliability Concepts, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Consistency of Replicated Databases, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service, NoSQL: Aggregate Data Models, Distribution Models, Consistency, Version Stamps, Map Reduce, Polyglot Persistence.

References:

1. M. Tamer Ozsu, PatrickValduriez, "Principles of Distributed Database Systems", (3e), Springer, 2011.
2. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", (1e), Person Education, Inc., 2013.
3. Saeed K. Rahimi and Frank S, Haug, "Distributed Database Management Systems: A Practical Approach", (1e), John Wiely& Sons, 2010
4. Martin Kleppmann, "Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems",(1e), O'Reilly Media,Inc., 2017
5. Guy Harrison,"Next Generation Databases: NoSQL, NewSQL and BigData", (1e), Apress, 2015

CSE 5154 HIGH PERFORMANCE COMPUTING SYSTEMS [3 1 0 4]

Introduction to Parallel Computing, Parallel Computer Structures, Handler's classification, Feng's classification, Applications of parallel processing, Classification of pipeline processor, Nonlinear pipelining, Synchronous Parallel Processing, Inter-PE Communications, Interconnection network, Thread level parallelism and multiprocessors, Interconnection networks, Elementary Parallel Algorithms, Various models, Message Passing Programming, Message Passing Libraries, OpenCL Device Architectures, OpenCL Architectures, Heterogeneous Computing, OpenCL Standard, OpenCL Specification, Kernels and OpenCL execution models, Program layout, Memory model, Writing Kernels, Basic OpenCL examples, Thread structure, Work-item and work-group, OpenCL memory model, Example applications, Convolution, CUDA programming basics, CUDA programming model.

References:

1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing," Tata McGraw-Hill India, 2012.
2. John L. Hennessy, David A. Patterson,"Computer Architecture: A Quantitative Approach," (5e), 2014.
3. Michael J Quinn, "Parallel Computing: Theory and Practice", (2e), Tata McGraw Hill, 2002.
4. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP," McGraw Hill, 2003.
5. Benedict R. Gaster, Lee Howes, David R, Perhaad Mistry, Dana Schaa, "Heterogeneous Computing with OpenCL," Morgan Kaufmann, 2012.
6. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors,A Hands-on Approach,"(2e),Elsevier, 2012.

CSE 5161 COMPUTING LAB-I [0 0 6 2]

Experiments based on theory covered in Advanced Database Systems, Advanced Computer Networks and High Performance Computing Systems. In the latter half of this lab, students will be working on more complex problems.

CSE 5162 PROGRAM LAB [0 0 3 1]

This lab will provide a platform for students to strengthen their programming skills and enhance their understanding of the application of the various language elements. In the latter half of this lab, students will enhance their problem-solving skills by building solutions to more complex problems.

SEMESTER II

CSE 5253 ADVANCED SYSTEMS SOFTWARE [3 1 0 4]

Introduction, Language Processors, The Structure of a Compiler, Role of the Lexical Analyzer, Input Buffering, Recognition of Tokens, LexicalAnalyzer Generator, Introduction to Syntax Analysis, Writing a Grammar, Top Down and Bottom Up Parsing, LR parsers, Syntax Directed Translation and Definitions, Evaluation order for SDD's, Applications, Intermediate Code Generation, Variants of Syntax Trees, Three Address Code, Type and Declarations, Translation of Expressions, Issues in Design of Code Generator, The Target Language, Basic Blocks, Flow Graphs, Distributed Systems Architecture, Design goals, Types, Styles, Middleware organization, System architectures, Example architectures, Coordination, Clock synchronization, Logical clocks, Mutual exclusion, Election Algorithms, Location systems, Distributed event matching, Gossip-based coordination, Introduction, Data-centric and client-centric consistency models, Replica management, Consistency protocols, Example, Introduction to Fault Tolerance, Process resilience, Reliable client-server communication, Reliable group communication, Distributed commit, Recovery.

References:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers Principles, Techniques and Tools", (2e), Pearson Education, 2010.
2. Andrew S. Tannenbaum, Maarteen Van Steen: "Distributed Systems, Principles and Paradigms", (3e), Version 3.01, 2017.
3. Kenneth C. Louden, "Compiler Construction - Principles and Practice", (1e), Thomson, 2007.
4. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems, Concepts and Design", (4e), Pearson Education, 2009.

CSE 5254 FUNDAMENTALS OF QUANTUM COMPUTING [3 1 0 4]

Introduction, Fundamental concepts. Quantum bits, Quantum computation, Quantum algorithms, Quantum Information, Introduction to Quantum Mechanics, Liner algebra, Postulates of quantum mechanics, Quantum Computation, Quantum circuits, Controlled operations, Measurement, Universal quantum gates, The Quantum Fourier Transform, The quantum Fourier transform, Phase estimation, Applications, Quantum Search Algorithms, Quantum counting, Speeding up the solution of NP-Complete problems, Quantum Information, Classical noise and Markov processes, Quantum Operations, Quantum Error Correction, The Shor code, Theory of quantum error correction, Entropy and Information, Shannon entropy, Basic properties of entropy, Von Neumann entropy, Quantum Information Theory, Distinguishing quantum states and the accessible information, Data compression, Classical information versus noisy quantum channels, Quantum information versus noisy quantum channels, Entanglement as a physical resource, Quantum cryptography.

References:

1. Michael A Nielsen, and Isaac L. Chuang "Quantum Computation & Quantum Information", (10e), Cambridge University Press, 2011.
2. F. Benatti, M. Fannes, R. Floreanini, and D. Petritis, "Quantum Information, Computation and Cryptography" Springer, 2010.
3. Mika Hirvensalo, "Quantum Computing", (2e), Springer-Verlag New York, 2004.
4. JozefGruska, "Quantum Computing", McGraw Hill, 1999.
5. Phillip Kaye, Raymond Laflamme and Michele Mosca, "An Introduction to Quantum Computing", Qxford University Press, 2006.

CSE 5261 COMPUTING LAB II [0 0 6 2]

Experiments based on theory covered in Advanced Systems Software and Object Oriented Systems Design. In the latter half of this lab, students will be working on more complex problems.

SEMESTER III and IV

CSE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CSE 5001 ADVANCED COMPUTER GRAPHICS [4 0 0 4]

Introduction, Graphics pipeline, Essential Mathematics and the Geometry of 2-Space and 3-Space, Operations on coordinates, polygons, Ray-Casting Renderer, Rasterization, Rendering with a Rasterization API, Performance and Optimization, Textures and Texture Mapping, Variation of Texturing, Building Tangent Vectors from a Parameterization, Codomains for Texture Maps Variations of texturing, Splines and Subdivision Curves and surfaces, Basic polynomial curves, Cubic B-splines, Catmull-Clark Subdivision Surfaces, Physics of light, Fresnel's Law and Polarization, Modelling and measuring light, Standard description of color, Color models, Shaders, Phongshaders, Toon Shading, Introduction to motion, Pose interpolation, Modern Graphics Hardware, Architecture, Parallelism, Programmability, GPUs as Compute Engines.

References:

1. John F. Hughes, Andries Van Dam, Morgan Mc Guire ,David F. Sklar , James D. Foley, Steven K. Feiner and Kurt Akeley, "Computer Graphics: Principles and Practice", (3e), Addison- Wesley Professional, 2013.
2. Edward Angel, "Interactive Computer Graphics A Top Down Approach with WebGL", (7e), Pearson Education, 2014.

CSE 5002 ALGORITHMIC FOUNDATIONS OF DATA SCIENCE [4 0 0 4]

High-Dimensional Space, Best-Fit Subspaces And Singular Value Decomposition (SVD) Random Walks And Markov Chains, Machine Learning: The Perceptron algorithm, Kernel Functions, Generalizing to New Data, Overftting and Uniform Convergence, Regularization: Penalizing Complexity, Online Learning, Online to Batch Conversion, Support-Vector Machines, VC-Dimension, Strong and Weak Learning, Deep Learning,Algorithms For Massive Data Problems: Frequency Moments of Data Streams, Matrix Algorithms using Sampling, Sketches of Documents, Clustering Algorithms, Community Finding and Graph Partitioning, Spectral clustering applied to social networks, Random Graphs . Topic Models, Nonnegative Matrix Factorization, Hidden Markov Models, And Graphical Models, Ranking and Social Choice, Compressed Sensing and Sparse Vectors

References:

1. Avrim Blum, John Hopcroft, and Ravindran Kannan, "Foundations of Data Science", https://www.cs.cornell.edu/jeh/book.pdf
2. Chandrajit Bajaj, "A Mathematical Primer for Computational Data Science", http://www.cs.utexas.edu/~bajaj/math-ds.pdf
3. Steele, Brian, Chandler, John, Reddy, Swarna,"Algorithms forData Science", (1e), Springer, 2016
4. Caathy O'Neil, Rachel Schutt, "Doing Data Science", (1e), O'Reilly, 2013

CSE 5003 OBJECT ORIENTED SYSTEMS DESIGN [4 0 0 4]

The World of the Modern Systems Analyst, Object Oriented Development and the Unified Process, Project Management and the Inception Phase, The Requirements Discipline, Use Cases and Domain Classes, Use case modelling and detailed requirements, Design activities and Environments, Use Case Realization: The Design Discipline within Unified Process Iterations, Few Creational Design Patterns, Few Structural Design Patterns, Few Behavioral Design Patterns, Advanced Topics in Object Oriented Design, Designing the Data Access Layer, Designing the User Interface Layer, Designing System Interfaces, Controls and Security, Software Quality Assurance, System Usability and Measuring User Satisfaction

References:

1. Satzinger, Jackson, Burd, "Object-Oriented Analysis and Design With the unified Process", Thomson, 2007.
2. James W Cooper, "The Design Patterns – Java Companion", 1998.
3. Ali Bahrami, "Object Oriented Systems Development", Tata McGraw-Hill, 2012.
4. James Rumbaugh, Ivar Jacobson, Grady Booch, "The Unified Modeling Language Reference Manual", Addison Wesley, 1999.
5. Tom Pender, "UML Bible", Wiley, 2003.
6. UML 2.0 Superstructure - Final Adopted Specification. Object Management Group, 2003 http: //www.omg.org/docs/ad/03-08-02.pdf.

CSE 5004 LOGIC AND FUNCTIONAL PROGRAMMING [4 0 0 4]

Starting Prolog, Prolog Programs, Data Objects in Prolog: Prolog Terms, Clauses, Predicates, Loading Clauses, Variables, Introduction, Unification, Evaluating Goals, Backtracking, A Summary, Removing Common Variables, A Note on Declarative Programming, Operators, Arithmetic, Equality Operators, Logical Operators, Introduction, Outputting Terms, Inputting Terms, Input and Output using Characters, Outputting and Inputting Characters, Using Characters, Input and Output using Files, File Output: Changing the Current Output Stream, File Input: Changing the Current Input Stream, Reading from Files, Using Files, Introduction, Looping a fixed number of times, Looping until a condition is satisfied, Backtracking with Failure, Preventing Backtracking, Sessions and Scripts, Evaluation, Values, Function, Definitions, Types, Specifications, Booleans, Characters, Enumerations, Tuples, Other types, Type synonyms, Strings, Natural numbers, Induction, The fold function, Haskell numbers, Examples, Church numbers, List notation, List operations, Map and filter, Zip, The fold function, Laws of fold, Examples, Trees.

References:

1. Max Bramer,"Logic Programming with Prolog", (1e), Springer, 2005.
2. Richard Bird, "Introduction to Functional Programming using Haskell" (2e), Prentice Hall Europe, 1998.

CSE 5005 COMPUTER VISION & IMAGE PROCESSING [4 0 0 4]

INTRODUCTION: Introduction to computer vision and its applications, Image formation, Geometric primitives and transformations. IMAGE PROCESSING: Point operators, Linear filtering, More neighbourhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization. FEATURE DETECTION AND MATCHING: Points and patches, Edge Detection methods (Laplacian detectors and Canny edge detector), Harris corner detector, Histogram of Gradients, SIFT, Colour and Texture, Feature based alignment, least squares and RANSAC. CAMERA CALIBRATION: Camera models, Stereo vision, Stereo correspondence, Epipolar geometry. TRACKING: Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense motion estimation. 3D CONSTRUCTION: Shape from X, Surface representations, Point-based representations, Model-based reconstruction, Recovering texture maps. OBJECT RECOGNITION: SVM, Face detection and recognition, Bag of words, Deep learning.

References:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications," Springer 2011.
2. David A. Forsyth and Jean Ponce, "Computer Vision: A Modern Approach," PHI learning 2015.
3. Jan Erik Solem, "Programming Computer Vision with Python," O'Reilly, 2012

CSE 5006 PATTERN CLASSIFICATION [4 0 0 4]

Introduction, Definition of Patterns, Paradigms of Pattern Recognition, Representation of Patterns and Classes, Metric and Non Metric Proximity Measures, Feature extraction, Different Approaches to Feature Selection, Nearest Neighbour Classifier and Variants, Algorithm for Nearest Neighbour Classification, Algorithms for Prototype Selection, Bayes Classifier, Decision Trees, Linear Discriminant Functions, Support Vector Machines, Clustering, Clustering Large Data Sets, Combination of Classifiers, Document recognition.

References:

1. Devi V. S., Murty M. N.,"Pattern Recognition: An Introduction," University Press, Hyderabad, 2011.
2. R. O. Duda, P. E. Hart, "Pattern Classification," Wiley, 2000.

CSE 5007 EMBEDDED SYSTEMS [4 0 0 4]

Introduction to Embedded systems: introduction, classification, purpose, domain specific and application specific embedded systems, Basic Embedded Processor/Microcontroller Architecture: ARM Cortex M processor, ARM addressing modes, Instruction set-data transfer, arithmetic and logical, shift and rotate, branch instructions, Functions, Conditional execution, UART, SSI, SPI, Timers and Counters: features of timers T0 and T1, Real-time operating systems (RTOS) based embedded system design: Operating System basics, types, tasks, process and threads, task scheduling, device drivers RTOS programming tools-MICRO C/OS-II AND VxWORKS, Internet of things: Basic concepts, UDP and PCP packets, Web server, UDP communication for WiFi, Bluetooth fundamentals, Bluetooth protocol stack, Client-Server Paradigm Network processor interface, Application layer protocols for Embedded systems, Commercially available RTOS

References:

1. Jonathan W. Valvano., "Embedded systems: Introduction to ARM Cortex-M Microcontrollers" (5e), Createspace Independent publishing platform, June 2014.
2. Jonathan W. Valvano, "Real-Time Operating System for ARM Cortex-M Microcontrollers", (4e), Createspace Independent Publishing Platform, 2019.
3. Jonathan W. Valvano., "Embedded systems: real-time interfacing to ARM Cortex-M microcontrollers" (4e), Createspace Independent Publishing Platform, 2017.
4. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi, Janice Mazidi , "ARM Assembly Language Programming & Architecture" (2e), MicroDigitalEd, 2016
5. Shibu K V, "Introduction to Embedded Systems", TataMcGrawHill, 2012.

CSE 5008 FUNDAMENTALS OF THEORETICAL COMPUTER SCIENCE [4 0 0 4]

Introduction, Review of Automata theory, Computability, and Complexity, Mathematical Notations and Terminology, Computability Theory, The Church-Turing Thesis, Turing Machines, Variants of Turing Machines, The definition of Algorithm, Decidability, Decidable Languages, The Halting Problem, Reducibility, The Recursion Theorem, Decidability of Logical Theories, Turing Reducibility, Complexity Theory, Time Complexity, Measuring Complexity, The Class P, The Class NP, NP-completeness, NP-Complete Problems, Space Complexity, Savitch's Theorem, The class PSPACE, PSPACE-completeness, The Classes L and NL, NL-completeness, NL equals coNL, Intractability, Hierarchy theorems, Relativization, Circuit Complexity. The Satisfiability problem, NP-Completeness of the SAT Problem, NP-Completeness of CSAT, Complements of Languages in NP, Problems Solvable in Polynomial

Space, A Problem That Is Complete for PS, Language Classes Based on Randomization, The Complexity of Primality Testing.

References:

1. Michael Sipser, "Introduction to the Theory of Computation", (3e) Thomson, 2014.
2. H.R. Lewis and C.H. Papadimitriou, "Elements of the Theory of Computation", (2e) Prentice-Hall, 1997.
3. Sanjeev Arora and Boaz Barak, "Computational Complexity A Modern Approach", Cambridge University Press, 2009.
4. John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman, "Introduction to Automata Theory, Languages, and Computation", (3e), Pearson Education India, 2009.

CSE 5009 PARALLEL ALGORITHMS [4 0 0 4]

Parallel Algorithm Design, Parallel Processing Terminology, Sieve of Eratosthenes, Control parallel and data parallel approach, PRAM model of Parallel Computation, PRAM Algorithms, Parallel Reduction, Tree Traversal, Merging sorted Lists, Graph Coloring, Scaled Speedup and Parallelizability, Amdahl's Law, Gustafson-Barsis's Law, Karp-Flat Metric, Elementary Parallel Algorithms, Parallel Algorithms for Processor Arrays, Parallel Algorithms for Multiprocessors, Parallel Algorithms for Multicomputers, Monte Carlo Methods of Parallel Random Number Generators, Case studies, Solving Linear Systems, Back Substitution, Odd-Even Reduction, Gaussian Elimination, Iterative Methods, Multigrid Methods, Sorting: Lower Bounds on Parallel Sorting, Bitonic Merge sort algorithms, Fundamental design issues in Parallel Computing, Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms.

References:

1. Michael J Quinn, "Parallel Computing- Theory and Practice," McGraw-Hill Inc., 2008.
2. Michael J Quinn, "Parallel Programming in C with MPI and OpenMP," McGraw Hill Education Private Limited, 2012.
3. David E. Culler, "Fundamental Design Issues", Computer Science Division, U.C. Berkley, 2012.
   https://slideplayer.com/slide/12297957/

CSE 5010 NATURAL LANGUAGE PROCESSING [4 0 0 4]

Introduction to Natural Language Processing, Morphology and Finite State Transducers, Finite-State Transducers, FSTs for Morphological Parsing, Lexicon-Free FSTs. Words and sentence tokenization, Detecting and Correcting Spelling Errors. N-Grams, Simple(Unsmoothed) N-Grams, Training and Test Data, Smoothing, Interpolation, Backoff. Word classes and Part of Speech Tagging: English Word Classes, Tag-sets for English, Part-of-Speech Tagging, Formal Grammars of English, The Penn Treebank project, Dependency Grammar. Parsing with Context Free Grammars, CKY algorithm. Statistical Parsing: Probabilistic Context-Free Grammars. Dependency Grammar. Semantics predicate argument structure, First order predicate language, Syntax driven semantic analysis, Lexical semantics, Wordnet, Word sense disambiguation, Information retrieval, Introduction to Machine Translation.

References:

1. Daniel Jurafsky& James H. Martin, "Speech and Language Processing", (2e), Pearson, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", (1e), O'Reilly Media, 2009.
3. Akshar Bharati, Rajeev Sangal and Vineet Chaitanya, "Natural Language Processing: A Paninian Perspective", Prentice-Hall of India, New Delhi, 1995.
4. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python – Analysing Text with natural language toolkit", O'Reilly Media, 2009.
5. Chris Manning, HinrichSchutze, "Foundations of Statistical Natural Language Processing",MIT Press, Cambridge, 1999.

CSE 5011 WEB SERVICES [4 0 0 4]

XML Technologies: XML, XML Namespaces, XML Schema Definition Language (XSD), XML Path Language (XPath), Web Technologies: XHTML and HTML5, Javascript, AJAX, Parsing XML with DOM, Web Services Technologies: Web Services Definition Language (WSDL), Simple Object Access Protocol (SOAP), Universal Description, Discovery, and Integration (UDDI), Representational State Transfer (ReST), Creating and Deploying Web Services, Building a Client to Consume Web Service, Semantic Web Services: Web Services to Semantic Web Services, OWL-S, WSDL-S, Service Oriented Architecture (SOA): Realizing the Promise of SOA, Architecture Fundamentals, Composing Services, SOA Security, SOA Governance, Resource Oriented Architecture (ROA): JSON, Resources and Representation, Designing a ReST Service, ReST vs SOAP, Securing a ReST Service, Creating and Consuming ReST Services, Deploy and Manage API on Amazon Web Services (AWS), Microservices: Architecture, Key Benefits, Compare Microservices with SOA, Integration, Building and Consuming Microservices.

References:

1. Joe Fawcett, Liam R. E. Quin and Danny Ayers, "Beginning XML", (5e), Wrox, 2012.
2. Liyang Yu, "Introduction to the Semantic Web and Semantic Web Services", (1e), Taylor & Francis Group, 2007.
3. Michael Rosen, Boris Lublinsky, Kevin T. Smith and Marc J. Balcer, "Applied SOA: Service-Oriented Architecture and Design Strategies", (1e), Wiley, 2008.
4. Leonard Richardson, Mike Amundsen and Sam Ruby, "RESTful Web APIs", (1e), O'Reilly, 2013.
5. Sam Newman, "Building Microservices", (1e), O'Reilly, 2015.

CSE 5012 ADVANCED MACHINE LEARNING [4 0 0 4]

Well-posed learning problems, designing a learning system, concept learning as search, Feature extraction, and feature selection. Metric and Non-Metric Proximity Measures, Modified KNN, Fuzzy KNN,Decision boundaries, Discriminate Functions, univariate and multivariate parameter estimations. Efficient Nearest Neighbour Classifier: Branch and bound, cube, projection, ordered partion, Minimal Distance Classifiers: centroid, condensed. Data organization, Hierachical, Agglomerative, Divisive and partition clustering, Fuzzy K-means, Incremental clustering: Leader, Birch, CF-tree, Model selection for latent variable models and evolutionary algorithms. Entropy and information gain estimation techniques, splitting attribute procedure, Random Forest decision tree representation. Appropriate problems for neural network learning, Multilayer network and the back propagation algorithm for classification of unconstrained document images. KSOM Algorithms, Radial basis functions. Conditional Independence, Parameter estimation, Minimum error-rate classification, Minimum error rate, discriminant functions. Ensemble models.

References:

1. Machine Learning – Tom M. Mitchell, - MGH, 2013.
2. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 2001.
3. EthemAlpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005
4. Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009

OPEN ELECTIVES

CSE 5051 DEEP LEARNING [3 0 0 3]

Introduction to neural networks: Humans Versus Computers, Basic Architecture, Training, Practical Issues, Common Neural Architectures, Advanced Topics. Machine learning with shallow neural networks: Binary and Multiclass Models, Autoencoders. Fundamentals of deep networks: What is Deep Learning, Architectural Principles, Building blocks. Training deep neural networks. Gradient-Descent Strategies, Batch Normalization, Acceleration and Compression. Recurrent neural networks (RNN): Architecture, Challenges, Echo State Networks, Long Short Term Memory, Gated Recurrent Units, Applications of RNN. Convolutional neural networks (CNN): Basic Structure, Training a CNN, Case studies of Convolutional Architectures, Visualization and Unsupervised Learning; Autoencoders. Applications of CNN. Advanced topics in deep learning: Attention mechanisms, Generative Adversarial Networks, Competitive Learning.

References:

1. Charu C Aggarwal, "Neural Networks and Deep Learning", Springer International Publishing,2018.
2. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", Oreilly, 2018.
3. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
4. Relevant research papers.

CSE 5052 SOFTWARE PROJECT MANAGEMENT AND QUALITY ASSURANCE [3 0 0 3]

Importance of Software Project Management, Management Principles, Strategic Program Management, Stepwise Project Planning. Project Schedules, Critical Path (CRM) Method, Risk Identification, Cost Schedules. Framework for Management and Control, Collection of Data Project Termination, Managing People, Organizational Behavior, Decision Making, Team Structures, Communication Plans, Case study. Need for Software Quality, Software Quality Assurance, Software Quality factors, Software Development methods, Quality Assurance Activities, Software Maintenance Quality, and Project Management. Staff Training and Certification Corrective and Preventive Actions, Project Process Control, Computerized Tools, Software Quality Metrics, Limitations of Software Metrics, Cost of Software Quality, Classical Quality Cost Model, Extended Model, Application of Cost Model.

References:

1. Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management" (5e), Tata McGraw Hill, New Delhi, 2012.
2. Robert K. Wysocki, "Effective Software Project Management" (4e) – Wiley Publication, 2011.
3. Gopalaswamy Ramesh, "Managing Global Software Projects" – McGraw Hill Education (India), Fourteenth Reprint 2013.
4. Rajib Mall, "Fundamentals of Software Engineering" PHI Learning PVT. LTD, 4th Edition, 2014
5. Marcelo Marinho et.al; "A Systematic review of Uncertainties in Software Project Management", International Journal of Software Engineering & Applications (IJSEA), Vol.5, No.6, November 2014.
6. Daniel Galin, "Software Quality Assurance", ISBN 0201 70945 7, Pearson Publication, 2009.
7. Alan C. Gillies, "Software Quality: Theory and Management", International Thomson Computer Press, 1997.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, MIT Manipal

M.Tech. COMPUTER SCIENCE AND INFORMATION SECURITY

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5152	Computational Methods and Stochastic Processes	4	0	0	4	CSE 5271	Cryptanalysis	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CSE 5254	Fundamentals of Quantum Computing	3	1	0	4
	CSE 5151	Advanced Computer Networks	3	1	0	4	CSE ****	Elective I	4	0	0	4
	CSE 5152	Advanced Data Structures and Algorithms	3	1	0	4	CSE ****	Elective II	4	0	0	4
	CSE 5153	Advanced Database Systems	3	1	0	4	CSE ****	Elective III	4	0	0	4
	CSE 5171	Advanced Cryptography	3	1	0	4	*** ****	Open Elective	3	0	0	3
	CSE 5162	Program Lab	0	0	3	1	CSE 5262	Information Systems Lab II	0	0	6	2
	CSE 5163	Information Systems Lab I	0	0	6	2						
		Total	**17**	**4**	**12**	**25**		**Total**	**21**	**2**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	CSE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CSE 5005	Computer Vision and Image Processing	CSE 5018	Database and Application Security
CSE 5012	Advanced Machine Learning	CSE 5019	Distributed and Cloud Security
CSE 5013	System and Network Security	CSE 5020	Hardware Security
CSE 5014	Cyber Forensics	CSE 5021	Information Security Management
CSE 5015	Blockchain Technology and Applications	CSE 5022	Internet of Things Security
CSE 5016	Cyber Law and Ethics	CSE 5023	Mobile and Wireless Security
CSE 5017	Data Hiding	CSE 5024	Secure Software Design

OPEN ELECTIVES			
CSE 5051	Deep Learning	CSE 5052	Software Project Management and Quality Assurance

SEMESTER I

MAT 5152 COMPUTATIONAL METHODS AND STOCHASTIC PROCESSES [4 0 0 4]

Random variables, one and two dimensional random variables, expectation, variance, covariance and correlation coefficient of random variables, uniform distribution, Functions of random variables, Bayesian estimation, credible intervals, Bayesian Hypothesis. Statistics of stochastic processes, Stationarity; Autocorrelation, Power density spectrum. Markov Models, Gaussian mixturemodels. Data Analysis, Regression, Predicting realvalue outputs. Optimization Techniques, Mathematical formulation of linear programming problems, Simplex method. Numerical solution to BVP's by finite difference & finiteelement methods. Solution of parabolic elliptic, hyperbolic PDEs. LinearAlgebra, several decompositions and Singular Value decomposition (SVD). Basics of Graph theory, connectivity, spanning tree and traversability. Two person zero sum game theory, non- zero sum game theory. Dominance Method, Graphical Method.

References:

1. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
2. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.
3. Applied Numerical Methods McGraw Hill.
4. HamdyA.Taha – Operations Research McGraw Hill.
5. Frank Harary, Graph Theory, Narosa Publishing House 2001.
6. David C Lay, Linear Algebra and its Applications, Pearson Publications (Third Edition).
7. NarsinghDeo, Graph Theory with Applications to Engg. and Computer Science, PHI Learning Private Ltd

HUM5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods - Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

The Lab focusses on enabling students to develop experiments, analyze data, think critically about theory and data and communicate their results and analysis in writing and oral presentation.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo& David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain& Cox, Experimental Designs, II Edn. Wiley Publishers, 2006

CSE 5151 ADVANCED COMPUTER NETWORKS [3 1 0 4]

Unmanned aerial vehicle(uav) networks: Introduction, challenges, key issues, comparative study, UAV features, Multi-UAV network, UAV network topologies, categorization, self-organization in UAV networks, UAV routing protocols, Handoffs in UAV networks. SDN: Benefits, Use cases, Controllers, Policies, Overlays, Automating Cloud via SDN. Supporting Multivendor Ecosystems. Data Center Evolution: Modern Data Center, Monolithic Storage Array, Virtualization, Convergence, the Role of Cloud, Cloud Types, Cloud Drivers. Emerging Data Center Trends, Hyperconverged Infrastructure. Multimedia Networking: Types of Multimedia, Streaming, DASH. CDN, Case Studies. VoIP. Best-Effort Service, Jitter, Best-Effort Networks, QoS Guarantees, Resource Reservation, Call Admission. Optical Networks: Multiplexing, Generations, Switching, Transparency. WDM Network Elements: Optical Line Terminals, Amplifiers, Multiplexers, OADM Architectures. Network Survivability: Basic Concepts, Self-Healing rings, Protection, Resilient Packet Rings, Service Classes.

References:

1. Brian Underdahl and Gary Kinghorn, “Software Defined Networking For Dummies”, Cisco Special Edition, John Wiley & Sons, Inc., 2015.
2. Scott D. Lowe, James Green, and David Davis, “Building a Modern Data Center: Principles and Strategies of Design”, ActualTech Media, USA, 2016.
3. James F. Kurose, Keith W. Ross, “Computer Networking-A Top Down Approach”, (6e), Pearson, 2013.
4. Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, “Optical Networks -A Practical Perspective”, (3e), Morgan Kaufmann, 2010.

CSE 5152 ADVANCED DATA STRUCTURES AND ALGORITHMS [3 1 0 4]

Amortized Analysis: Aggregate analysis, The Aggregate analysis, The accounting method, The potential method, Dynamic Tables. B-Trees,: Basic operations on B-Trees, Deleting a key from a B-Tree. Binomial trees and Binomial heaps: Operations on Binomial heaps. Structure of Fibonacci heaps, Mergeable heap operations, Decreasing a key and deleting a node. The van EmdeRoas Tree: Preliminary approaches, A recursive structure, Disjoint-set operations: Linked-list representation of disjoint sets, Disjoint set forests. Single-Source Shortest Path: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Difference constraints and shortest paths. All-Pairs Shortest Paths: shortest Paths and matrix multiplication, Johnson's algorithm for sparse graphs. Maximum Flow: Flow Networks, The Ford-Fulkerson method, Maximum Bipartite Matching, Multithreaded Algorithms: The basics of dynamic multithreading, Multithreaded matrix multiplication , Multithreaded merge sort.

References:

1. Cormen Thomas H., Leiserson Charles E, Rivest Ronald L. and Stein Clifford, “Introduction to Algorithms”, (3e), MIT Press, 2009.
2. Cormen Thomas H., Leiserson Charles E, Rivest Ronald L. and Stein Clifford, “Introduction to Algorithms” (2e), Prentice-Hall India, 2001.
3. Baase Sara and Gelder A.V., “Computer Algorithms -Introduction to Design and Analysis”, (3e), Pearson Education, 2000
4. Anany Levitin, “Introduction to the Design and Analysis of Algorithms“, (3e), Pearson Education, 2011

CSE 5153 ADVANCED DATABASE SYSTEMS [3 1 0 4]

Introduction to Distributed Data Processing, Top-Down Design Process, Distributed Design Issues, Fragmentation, Allocation, Data Directory, Data Access Control, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing Properties of Transactions, Types of Transactions, Serializability Theory, Locking-Based Concurrency Control Algorithm, Timestamp-Based Concurrency Control Algorithm, Dead lock Management, “Relaxed” Concurrency Control, Reliability Concepts, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Consistency of Replicated Databases, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service, NoSQL: Aggregate Data Models, Distribution Models, Consistency, Version Stamps, Map Reduce, Polyglot Persistence

References:

1. M. Tamer Ozsu, Patrick Valduriez, “Principles of Distributed Database Systems”, (3e), Springer, 2011
2. Pramod J. Sadalage, Martin Fowler, “NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence', (1e), Person Education, Inc., 2013.
3. Saeed K. Rahimi and Frank S, Haug, “Distributed Database Management Systems: A Practical Approach”, (1e), John Wiely& Sons, 2010
4. Martin Kleppmann, “Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems”, (1e), O'Reilly Media,Inc., 2017
5. Guy Harrison,“Next Generation Databases: NoSQL, NewSQL and BigData”, (1e), Apress, 2015

CSE 5171 ADVANCED CRYPTOGRAPHY [3 1 0 4]

Groups, rings, Fields, Characteristic of a field, prime fields, Arithmetic of polynomials over fields. Field extensions, Galois group of field extensions, Fixed field and Galois extensions. Minimum polynomial, Splitting field of a polynomial, Separable polynomial and Separable extensions. Construction of finite fields and their structure. Enumeration of irreducible polynomials over finite fields. The fundamental theorem of Galois Theory. ElGamal Cryptosystem, Elliptic Curve Architecture, and Cryptography: Elliptic Curve over real numbers, Elliptic Curve Cryptography, ECDH, ECDSA. RSA variants. Authentication functions, Message Authentication Codes and systems, Advanced Digital signature systems. Entity Authentication, One-time password, Challenge – Response: using a symmetric- key cipher, using keyed-hash functions, using as an asymmetric-key cipher, using a digital signature, Zero-Knowledge proof, Fiat. -Shamir protocol, Feige-Fiat-Shamir protocol, Guillou-Quisquater protocol, Biometric, Key Management: Symmetric key distribution, servers. the symmetric key agreement, Deffie-Hellman key agreement, Station to station key agreement. public key distribution, public announcements, certification authority, public key infrastructure, trust model, hijacking.

References:

1. Behrouz A. Forouzan and Debdeep Mukhopadhyay – “Cryptography and Network Security”, McGraw Hill, 2nd Edition, 2008.
2. S. Vaudenay, “A Classical Introduction to Cryptography: Applications for Communications Security”, Springer International Edition, 2006.
3. Lawrence C. Washington, “Elliptic curves: number theory and cryptography”, Chapman & Hall/ CRC Second Edition, 2008.
4. William Stallings,“Cryptography And Network Security Principles And Practice”, Fifth Edition, Pearson Education,2013

CSE 5162 PROGRAM LAB [0 0 3 1]

This lab will provide a platform for students to strengthen their programming skills and enhance their understanding of the application of the various language elements. In the latter half of this lab, students will enhance their problem-solving skills by building solutions to more complex problems.

CSE 5163 INFORMATION SYSTEMS LAB-I [0 0 6 2]

Experiments based on theory covered in Advanced Database Systems, Advanced Computer Networks and Number Theory and Cryptography. In the latter half of this lab, students will be working on more complex problems.

SEMESTER II

CSE 5271 CRYPTANALYSIS [3 1 0 4]

Historical cryptanalysis, Preliminaries, Security, attacks on modern block and stream ciphers, Correlation attacks, Algebraic attacks, Brute force cryptanalysis, Dictionary attacks, Brute force attacks, Attacks on public key cryptosystems, Eratosthenes's sieve, Improvements, Finding primes faster: Atkin and Bernstein's sieve, Birthday attacks, Analysis of birthday paradox bounds,Finding collisions, Pohlig-Hellman algorithm, Baby-step, giant-step algorithm, Birthday-based algorithms, Analysis of random functions, - Pollard's Rho factoring algorithm , Pollard's Rho discrete logarithm algorithm ,Pollard's kangaroos A direct cryptographic application in the context of blockwise security, Collisions in hash functions , Birthday attack on Plain RSA and plain ElGamal encryptions,Birthday attack on plain ElGamal, The elliptic curve factoring method- Pollard's p- 1 factoring, quadratic sieve,Discrete logarithms with the Gaussian integer method, Attacks on hash functions, Constructing number field sieve polynomials, A linear model of SHA, Searching for collision instances.

References:

1. Antoine Joux, “Algorithmic Cryptanalysis”, CRC Press, 2009
2. Gregory V. Bard, “Algebraic Cryptanalysis”, Springer, 2009.
3. Richard J Spillman, “Classical and Contemporary Cryptology”, Pearson Education, 2005.
4. Hans Delfs and Helmut Knebl, “Introduction to Cryptography: Principles and Applications”, Springer- Verlag, 2007.
5. Alfred John Menezes, Paul C. van Oorschot,Scott A. Vanstone “Handbook of Applied Cryptography”, CRC Press, 1996.

CSE 5254 FUNDAMENTALS OF QUANTUM COMPUTING [3 1 0 4]

Introduction, Fundamental concepts. Quantum bits, Quantum computation, Quantum algorithms, Quantum Information, Introduction to Quantum Mechanics, Liner algebra, Postulates of quantum mechanics, Quantum Computation, Quantum circuits, Controlled operations, Measurement, Universal quantum gates, The Quantum Fourier Transform, The quantum Fourier transform, Phase estimation, Applications, Quantum Search Algorithms, Quantum counting, Speeding up the solution of NP-Complete problems, Quantum Information, Classical noise and Markov processes, Quantum Operations, Quantum Error Correction, The Shor code, Theory of quantum error correction, Entropy and Information, Shannon entropy, Basic properties of entropy, Von Neumann entropy, Quantum Information Theory, Distinguishing quantum states and the accessible information, Data compression, Classical information versus noisy quantum channels, Quantum information versus noisy quantum channels, Entanglement as a physical resource, Quantum cryptography.

References:

1. Michael A Nielsen, and Isaac L. Chuang “Quantum Computation & Quantum Information”, (10e), Cambridge University Press, 2011.
2. F. Benatti, M. Fannes, R. Floreanini, and D. Petritis, “Quantum Information, Computation and Cryptography” Springer, 2010.
3. Mika Hirvensalo, “Quantum Computing”, (2e), Springer-Verlag New York, 2004.
4. JozefGruska, “Quantum Computing”, McGraw Hill, 1999.
5. Phillip Kaye, Raymond Laflamme and Michele Mosca, “An Introduction to Quantum Computing”, Qxford University Press, 2006.

CSE 5262 INFORMATION SYSTEMS LAB-II [0 0 6 2]

Experiments based on theory covered in Secure Software Design and System and Network Security. In the latter half of this lab, students will be working on more complex problems.

SEMESTER III and IV

CSE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CSE 5005 COMPUTER VISION & IMAGE PROCESSING [4 0 0 4]

INTRODUCTION: Introduction to computer vision and its applications, Image formation, Geometric primitives and transformations. IMAGE PROCESSING: Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization. FEATURE DETECTION AND MATCHING: Points and patches, Edge Detection methods (Laplacian detectors and Canny edge detector), Harris corner detector, Histogram of Gradients, SIFT, Color and Texture, Feature based alignment, least squares and RANSAC. CAMERA CALIBRATION: Camera models, Stereo vision, Stereo correspondence, Epipolar geometry. TRACKING: Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense motion estimation. 3D CONSTRUCTION: Shape from X, Surface representations, Point-based representations, Model-based reconstruction, Recovering texture maps. OBJECT RECOGNITION: SVM, Face detection and recognition, Bag of words, Deep learning.

References:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer 2011.
2. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, PHI learning 2015.
3. Jan Erik Solem, Programming Computer Vision with Python, O'Reilly, 2012

CSE 5012 ADVANCED MACHINE LEARNING [4 0 0 4]

Well-posed learning problems, designing a learning system,concept learning as search, Feature extraction, and feature selection.Metric and Non-Metric Proximity Measures, Modified KNN, Fuzzy KNN,Decision boundaries, Discriminate Functions, univariate and multivariate parameter estimations.Efficient Nearest Neighbor Classifier:Branch and bound, cube, projection, ordered partion,Minimal Distance Classifiers: centroid, condensed.Data organization,Hierachical, Agglomerative, Divisive and partition clustering, Fuzzy K-means, Incremental clustering: Leader, Birch, CF-tree, Model selection for latent variable models and evolutionary algorithms. Entropy and information gain estimation techniques, splitting attribute procedure, Random Forest decision tree representation.Appropriate problems for neural network learning, Multilayer network and the back propagation algorithm for classification of unconstrained document images. KSOM Algorithms, Radial basis functions.Conditional Independence, Parameter estimation, Minimum error-rate classification, Minimum error rate, discriminant functions.Ensemble models.

References:

1. Machine Learning – Tom M. Mitchell, - MGH, 2013.
2. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 2001.
3. EthemAlpaydin, “Introduction to Machine Learning”, Prentice Hall of India, 2005
4. Stephen Marsland, “Machine Learning –An Algorithmic Perspective”, CRC Press, 2009

CSE 5013 SYSTEM AND NETWORK SECURITY [4 0 0 4]

Introduction: CIA Triad, Defence Models, Computer Viruses: Genesis, Classification. Risk analysis: Threats, types of attacks, worms, trojans, buffer overflow, poisoning, risk analysis. Intrusion detection systems, types, changing nature of IDS tools, challenges, implementation, intrusion prevention systems, intrusion detection tools. Operating system security: OS models, classic security models, reference monitor, international standards for operating system security. Firewalls: Types, implementation, Demilitarized Zone, Firewall forensics, Firewall Services and Limitations. IPSec: IPv4 and Ipv6, SKIP, IKE phases, Session Keys, Message IDs, Phase 2/Quick Mode, Traffic selectors, IPSec SA. PGP: Overview, Key distribution, Efficient encoding, Signature Types, Key rings, Anomalies and Object formats. Kerberos: Version 4, Realms, Interrealm authentication, Message formats. Kerberos V5 ASN.1, KDC Database, Kerberos V5 Messages.

References:

1. Mark Rhodes Ousley, “The Complete Reference: Information Security”, (2e), Mc Graw HillPublication, 2013.
2. Peter Szor, “The art of Computer Virus Research and Defense”, Addison Wesley Professional, 2005.
3. Joseph MiggaKizza, “Guide to Computer Security”, (3e), Springer,2015.
4. Charlie Kaufman, Radia Perlman, Mike Speciner, “Network Security : PRIVATE Communication in a PUBLIC World”, (2e), Pearson Education, 2005.
5. William Stallings, “Cryptography and Network Security Principles and Practice”, (6e), Prentice Hall, 2014.

CSE 5014 CYBER FORENSICS [4 0 0 4]

Computer Forensic: History, Computer Investigations, Law Enforcements, Storage Format, Digital Evidence, Hash Functions, File Structures, Software Preview, Email Services, Forensic in Networks, Digital Emails, Forensic in Mobiles, High Technology Investigations, Forensic Witness's, Service Virtualization, Rogue Machines, Data Storage, Malware Forensics, Memory Forensics, Post Mortem Forensics, profiling Forensics, Service Virtualization, Virtual Privacy Machines, MS Analysis Tools, Forensic Compliance, Virtual Appliances, Encryption, Decryprtion, Volatile Data Collection, Process Models, Data Protection, File Signatures, Artifacts, Use Cases, report Writing, Expert Investigations, Case Hearing, Testimony, File Formats, Digital Emails, Email Investigations, Mobile Data Investigations.

References:

1. Bill Nelson, Amelia Philips, Frank Enfinger, ChristoferSteuart, Computer F0rensics and Investigations, Cengage Learning India Private Limited, 2009.
2. Eoghan Casey, Digital evidence and Computer Crime, Edition 3, Academic Press, 2011.
3. MrjieBritz, Computer Forensics and Cyber Crime, Edition 2, Prentice Hall, 2012.
4. Diane Barrett, Greg Kipper, Virtualization and Forensics, A Digital Forensic Investigator's Guide to Virtual Environments, Elsevier , 2010.
5. Malware Forensics Investigating and Analyzing Malicious Code, James M Aquilina, Eoghan Casey, Cameron H Malin, Elsevier, 2008.

CSE 5015 BLOCKCHAIN TECHNOLOGY AND APPLICATIONS [4 0 0 4]

Introduction, Structure of a Block, The Genesis Block, Linking Blocks in the Blockchain, Merkle Trees, Simplified Payment Verification, Using hash functions to chain blocks, for Proof-of-Work, Digital Signatures to sign transactions, Distributed Ledger, Byzantine Agreement, Eventual Consistency & Bitcoin Consistency- Availability and Partitions, Bitcoin, Smart Contracts, Weak Consistency, Distributed Storage, Consistent Hashing, Hypercubic Networks, Mining and Consensus: Decentralized Consensus, Independent Verification of Transactions Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block Header, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Consensus Attacks, Changing the Consensus Rules, Soft Fork Signaling with Block Version, Consensus Software Development, Ethereum and Bitcoin, block format, mining algorithm, proof-of-stake (PoS) algorithm, account management, contracts and transactions, Solidity language, account management, contracts and transactions, Applications of Blockchain :Case studies

References:

1. Andreas M. Antonopoulos, “Mastering Bitcoin: unlocking digital cryptocurrencies”, O'Reilly Media, (1e) 2014
2. Roger Wattenhofer, “Distributed Ledger Technology, The science of the Blockchain”, Inverted Forest Publishing, (2e), 2017.
3. Antonopoulos, Andreas M. and Wood, Gavin. “Mastering Ethereum”, O'Reilly Media, 2018.
4. George Icahn, “Blockchain:the complete guide to understanding blockchain technology”, Amazon publishers, 2017.

CSE 5016 CYBER LAW AND ETHICS [4 0 0 4]

Introduction To Cyberethics: Concepts, Perspectives, And Methodological Frameworks. Ethical Concepts And Ethical Theories: Establishing And Justifying A Moral System. Critical Reasoning Skills For Evaluating Disputes InCyberethics. Professional Ethics, Codes Of Conduct, And Moral Responsibility. Privacy And Cyberspace. Security In Cyberspace. Cybercrime And Cyber-Related Crimes. Intellectual

Property Disputes In Cyberspace. Regulating Commerce And Speech In Cyberspace. The Digital Divide, Democracy, And Work. Online Communities, Cyber Identities, And Social Networks. Ethical Aspects Of Emerging And Converging Technologies. Preliminary, Digital Signature, Electronic Governance, Attribution, Acknowledgment And Dispatch Of Electronic Records, Regulation Of Certifying Authorities, Duties Of Subscribers, Penalties And Adjudication, The Cyber Regulations Appellate Tribunal, Offences, Network Service Providers Not To Be Liable In Certain Cases, Miscellaneous. The Patents Act 1970-incorporating all amendments and rules-till 2015. Copy Right Act 1957-incorporating all amendments and rules-till 2015.

References:

1. Herman T. Tavani, "Ethics and Technology Controversies, Questions, and Strategies" (4e) Wiley, 2013.
2. The Information Technology 2000 (incorporating all amendments and rules-till 2015)-Bare Act
3. The Patents Act 1970(incorporating all amendments and rules-till 2015)-Bare Act
4. Copy Right Act 1957(incorporating all amendments and rules-till 2015)-Bare Act

CSE 5017 DATA HIDING [4 0 0 4]

Introduction, Steganography, and Watermarking, Importance of Watermarking and Steganography. Applications of Watermarking and Steganography, Properties of Watermarking and Steganography, Evaluating Watermarking and Steganographic Systems, Mathematical models for Information hiding, Steganographic Techniques, Steganographic Communication, Information-Theoretic Foundations of Steganography, Cachin's Definition of Steganography, Practical Steganographic Methods, Statistics Preserving Steganography, Model-Based Steganography, Minimizing the Embedding Impact, Steganalysis: Detection, Forensic Steganalysis, Some Significant Steganalysis Algorithms, Digital watermarking: Types and Approaches, Models of Watermarking, Informed Embedding, Watermarking using Side Information, Implementing DM with a Simple Lattice Code, Robust watermarking: Approaches, Robustness to Valumetric, Temporal and Geometric Distortions, Watermark Security: Security Requirements, Categories of Attacks.

References:

1. Ingemar Cox, Matthew Miller, Jeffrey Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", (2e), Morgan Kaufmann, 2007
2. WeiQi Yan, Jonathan Weir, "Fundamentals of Media Security", Ventus Publishing ApS, 2010.
3. Stefan Katzenbeisser and Fabien A.P. Petitcolas, "Information hiding techniques for steganography and digital watermarking", Artech House Inc, 2000.
4. Michael T. Raggo and Chet Hosmer, "Data Hiding: Exposing Concealed Data in Multimedia, Operating Systems, Mobile Devices and Network Protocols", Syngress, 2012.
5. HusrevSencar, MahalingamRamkumar, Ali Akansu, "Data Hiding Fundamentals and Applications", Academic Press, 2004.

CSE 5018 DATABASE AND APPLICATION SECURITY [4 0 0 4]

Introduction, Database security, Operating systems overview, security environment, Authentication methods, Vulnerabilities of operating systems, Defining and using profiles, Designing and implementing password policies, Granting and revoking user privileges, Obfuscate application code, Secure the database from SQL injection attacks, Beware of double whammies: Combination of SQL injection and buffer overflow vulnerability, Types of users, security models, application types, application security models and Data encryption, Implementing VPD, Implementing oracle VPD, Auditing overview, environment, process, objectives, classification and types, Benefits and side effects of auditing, Map data sources and sinks, Understand Web services security before exposing Web services endpoints, Auditing Database Activities: Introduction, usage of database activities, creating DLL triggers, auditing database activities with oracle, Security and Auditing project cases: Introduction, Case Study for developing an online database.

References:

1. Hassan A. Afyouni, Database Security and Auditing, India Edition, CENGAGE Learning, 2009.
2. RonBenNatan, Implementing Database Security and Auditing, Elsevier, Indian Reprint, 2006.
3. M.TamerÖzsu, Patrick Valdureiz, Principles of Distributed Database Systems, Prentice Hall, (2e), Springer, 2011.
4. Castano, Fugini, Database Security, Addison Wesley, ACM, 2004.
5. Clark, Holloway, The Security Audit and Control of Databases, List, UK, Ashgate, 2011.
6. Douglas, Security and Audit of Database System, Blackwell, UK, 2010.
7. Fernandez, Summers, Wood, Database Security and Integrity, Addison Wesley, 2012.

CSE 5019 DISTRIBUTED AND CLOUD SECURITY [4 0 0 4]

User Authentication and Access Control : Electronic User Authentication Principles, Password-Based, Token-Based, Biometric and Remote User Authentication, Access Control Principles, Attribute-Based Access Control, Identity, Credential, and Access Management, Trust Frameworks Application Level and service level Vulnerabilities and Attacks, Denial-of-Service Attacks and Intrusion detection, cloud software security, cloud computing risk issues and security challenges, Cloud Computing Risk Issues The CIA Triad Privacy and Compliance Risks Threats to Infrastructure, Data, and Access Control Cloud Service Provider Risks Summary, Cloud Computing Security Challenges Security Policy Implementation Virtualization Security Management Summary. cloud security architecture Issues Standards Incident Response Encryption and Key Management Retirement Summary.

References:

1. William Stallings Lawrie Brown "Computer Security Principles and Practice" (3e) Pearson-2015.
2. Abhijit Belapurkar, Anirban Chakrabarti, Harigopal Ponnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, Srikanth Sundarrajan , "Distributed Systems Security: Issues, Processes and Solutions", Wiley 2009.
3. Ronald L. Krutz, Russell Dean Vines "Cloud Security, A Comprehensive Guide to Secure Cloud Computing" Wiley; (1e)-2010.
4. Vines Russell Dean, "Cloud Security", Wiley 2015.

CSE 5020 HARDWARE SECURITY [4 0 0 4]

Introduction, Finite Fields. Advanced Encryption Standard (AES) Hardware, S-box. Introductionto Elliptic Curve Cryptography (ECC). The field-programmable gate array (FPGA) architecture, the FPGA design flow, the mapping of algorithm to hardware. Enhancing the performance of hardware design. Hardware design of AES, efficient design of Finite Field Arithmetic onFPGAs, high speed implementation of Elliptic Curve scalar multiplication on FPGAs. Introduction to Side Channel Analysis (SCA), Power attacks, Fault attacks, Cache attacks, Scan chain based attacks. Differential fault analysis of Ciphers, Cache attacks on ciphers, Power analysis of ciphers implementation, Countermeasures against SCA, Testability of cryptographic hardware. Overview techniques for hardware Trojan detection, Introduction PUFs. Design on FPGAs

References:

1. Debdeep Mukhopadhyay and RajatSubhra Chakraborty, "Hardware Security: Design, Threats and Safeguards ", CRC Press, 2015.
2. Mohammad Tehranipoor and Cliff Wang, "Introduction to Hardware Security and Trust ", Springer, 2011.
3. Nadia Nedjah and Luiza de MacedoMourelle, "Embedded Cryptographic Hardware: Design & Security , Nova Publishers, 2005.
4. Stefan Mangard and Elisabeth Oswald and Thomas Popp, "Power Analysis Attacks: the Secrets of Smart Cards ", Springer, 2007.

CSE 5021 INFORMATION SECURITY MANAGEMENT [4 0 0 4]

Introduction To Information Security, Characteristics of Information, NSTISSC Security Model, Components of an Information System, Security Systems Development Life Cycle, Security Professional and The Organization. Security Policies: Access Control Matrix, Confidentiality Polices: The Bell-LaPadula Model, Integrity Policies: Biba Integrity Model, The Clark-Wilson Integrity Model, Hybrid Policies: Chinese Wall Model. Threats, Attacks, An Overview of Risk Management, Risk Identification, Identifying Assets, Threats and Vulnerabilities, Risk Control Strategies, Selection A Risk Control Strategy. Quantitative Versus Qualitative Risk Control Practices, Planning For Security, Introduction To Assurance, Implementing Information Security, Vulnerability Analysis, Penetration Testing, Layering of tests, Vulnerability Classification Auditing, Anatomy of an auditing system, designing an auditing system, Auditing mechanisms, Audit browsing.

References:

1. Michael E. Whitman and Herbert J. Mattord, "Principles of Information Security", (6e), Thomson Learning, 2018.
2. Matt Bishop, Introduction to Computer Security, Pearson , 2011.

CSE 5022 INTERNET OF THINGS SECURITY [4 0 0 4]

Overview of Internet of Things (IoT), IoT architectures, applications of IoT, issues and challenges in IoT, future research directions in IoT security, System model for IoT, Evolution of the networks, vision of the Internet of Things- large scale ubiquitous and pervasive connectivity, Vulnerable features of the Internet of Things, threat taxonomy, system security threats, reflective trust and reputation threats, Making the IoT more secure and private, protocol and network security, data and privacy, identity management, trust management, fault tolerance, social awareness, Security protocols in IoT, authentication protocols in IoT, single-server authentication protocols, multi-server authentication protocols, attacks on IoT authentication protocols, informal and formal security proofs for IoT authentication protocols, access control protocols in IoT, privacy preserving data dissemination protocols in IoT, malware propagation and control technique in IoT. Case studies for selected IoT deployments,Internet of Vehicles (IoV), Healthcare of Things, Internet of Drones (IoD). Testbed implementations and simulations of IoT security protocols

References:

1. S. Misra, M. Maheswaran, S. Hashmi. "Security Challenges and Approaches in Internet of Things", (2e), Springer Briefs in Electrical and Computer Engineering, 2017.
2. C. Patel, N. Doshi, "Internet of Things Security: Challenges, Advances, and Analytics", (1e), CRC press, 2018.
3. F. Hu. "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations", (1e), CRC press, 2016.

CSE 5023 MOBILE AND WIRELESS SECURITY [4 0 0 4]

Introduction to Security and Privacy for Mobile and Wireless Networks, Pervasive Systems, Trust Negotiation- Extending Trust Negotiation to Support Privacy, Mobile system architectures and Security & Attacks, Wireless security, Attacking 802.11 Networks, Attacking WPA protected 802.11 Networks, Bluetooth Scanning, Bluetooth Eavesdropping, Attacking and Exploiting Bluetooth, Bluetooth Security solutions, ZigBee Security, ZigBee Attacks, Security in Ad Hoc Wireless Networks, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management in Ad hoc Wireless Networks, Key Management in Wireless Sensor Networks, Secure Routing in Ad hoc Wireless Networks, RFID: an anti-counterfeiting tool, Efficient and Secure RFID Security Method, Optimizing RFID protocols for Low Information Leakage, VoIP, IP Multimedia Subsystem (IMS), 4G security, Confidentiality, Attacks on wireless sensor networks and counter-measures, Prevention mechanisms: authentication and traffic protection.

References:

1. Lei Chen, Jiahuang Ji, Zihong Zhang, "Wireless Network Security", (1e), Springer Science & Business Media, 2013.
2. Johny Cache, Joshua Wright and Vincent Liu, Hacking, "Wireless Exposed: Wireless Security Secrets & Solutions", (3e), McGraw-Hill Osborne, 2015.
3. Kia Makki, Peter Reiher, "Mobile and Wireless Network Security and Privacy", (2e), Springer, 2010.
4. Noureddine Boudriga, "Security of Mobile Communications", (1e), CRC Press, 2009.
5. Kitsos Paris, Zhang Yan, "RFID Security Techniques, Protocols and System-On-Chip Design", (5e), Springer, 2011.

CSE 5024 SECURE SOFTWARE DESIGN [4 0 0 4]

Introduction to CIA triads, Fighting fire, The human Factor, The Network, Data-Centric Threats, Business Application, Introducing eve, The Science of Secrecy, Eve Unleashed, Malicious Modifications and Insidious Insertions, Play it Again, Eve in the Middle, Making the Connection, Roll Up the Welcome Mat, The Why in What and How, Business Application, Common Operating Systems, Operating Systems Threats, Operating System Defects Tactics, Auditing and Monitoring, Backup and Redundancy, Remote Access Security, Virtualization, The Logical Design, The physical design, Buffer Bashing, Good Input, Good Output, Inherent Inheritance and Overdoing Overloads, The Threat down, The Client a Risk, The Biggest Threats to Web Applications, Javascript and AJAX, Adobe Flash, ActiveX, Simplify, Restrict and Scrub, Prediction Through Penetration Testing, The Insider Threat and Beyond, Migration to Defend Against the Unknown, The Organization Incidence Response, The Business Continuity Plan, Becoming and Staying Proactive

References:

1. Theodor Richardson, “Secure Software Design”, (3e), Jones & Barlett Learning, MIT Press, 2013.
2. Markus Schumacher, Eduardo Fernandez-Buglioni, Duane Hyberstson, Frank Bushcmann, and Peter Sommerlad, "Security Patterns Integrating Systems Engineering”, Wiley Series in Software Design Patters, 2006
3. John Viega, Gary R. McGraw, "Building Secure Software: How to Avoid Security Problems the Right Way, Portable Documents", Pearson Education, 2006
4. Gary McGraw, "Software Security: Building Security in", Addison-Wesley Professional, 2006

OPEN ELECTIVES

CSE 5051 DEEP LEARNING [3 0 0 3]

Introduction to neural networks: Humans Versus Computers, Basic Architecture, Training, Practical Issues, Common Neural Architectures, Advanced Topics. Machine learning with shallow neural networks: Binary and Multiclass Models, Auto encoders. Fundamentals of deep networks: What is Deep Learning, Architectural Principles, Building blocks. Training deep neural networks. Gradient-Descent Strategies, Batch Normalization, Acceleration and Compression. Recurrent neural networks (RNN): Architecture, Challenges, Echo State Networks, Long Short Term Memory, Gated Recurrent Units, Applications of RNN. Convolutional neural networks (CNN): Basic Structure, Training a CNN, Case studies of Convolutional Architectures, Visualization and Unsupervised Learning; Autoencoders. Applications of CNN. Advanced topics in deep learning: Attention mechanisms, Generative Adversarial Networks, Competitive Learning.

References:

1. Charu C Aggarwal, “Neural Networks and Deep Learning”, Springer International Publishing, 2018.
2. Josh Patterson and Adam Gibson, “Deep Learning: A Practitioner's Approach”, Oreilly, 2018.
3. Ian Goodfellow, YoshuaBengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
4. Relevant research papers.

CSE 5052 SOFTWARE PROJECT MANAGEMENT AND QUALITY ASSURANCE [3 0 0 3]

Importance of Software Project Management, Management Principles, Strategic Program Management, Stepwise Project Planning. Project Schedules, Critical Path (CRM) Method, Risk Identification, Cost Schedules. Framework for Management and Control, Collection of Data Project Termination, Managing People, Organizational Behavior, Decision Making, Team Structures, Communication Plans, Case study. Need for Software Quality, Software Quality Assurance, Software Quality factors, Software Development methods, Quality Assurance Activities, Software Maintenance Quality, and Project Management. Staff Training and Certification Corrective and Preventive Actions, Project Process Control, Computerized Tools, Software Quality Metrics, Limitations of Software Metrics, Cost of Software Quality, Classical Quality Cost Model, Extended Model, Application of Cost Model.

References:

1. Bob Hughes, Mike Cotterell and Rajib Mall, “Software Project Management” (5e), Tata McGraw Hill, New Delhi, 2012.
2. Robert K. Wysocki, “Effective Software Project Management” (4e) – Wiley Publication, 2011.
3. Gopalaswamy Ramesh, “Managing Global Software Projects” – McGraw Hill Education (India), Fourteenth Reprint 2013.
4. Rajib Mall, “Fundamentals of Software Engineering” PHI Learning PVT. LTD, 4th Edition, 2014
5. Marcelo Marinho et.al; “A Systematic review of Uncertainties in Software Project Management”, International Journal of Software Engineering & Applications (IJSEA), Vol.5, No.6, November 2014.
6. Daniel Galin, “Software Quality Assurance”, ISBN 0201 70945 7, Pearson Publication, 2009.
7. Alan C. Gillies, “Software Quality: Theory and Management”, International Thomson Computer Press, 1997.

Department of Electrical & Electronics Engineering

Established in the year 1960, the Department of Electrical & Electronics Engineering has been at the forefront to produce well-groomed graduates, possessing sound technical skills and innovative ideas to cater to the ever growing demands of the industry. The department is backed by a team of motivated, dedicated and experienced teachers with expertise in key domains such as Power Systems, Power Electronics, Signal Processing, Illumination Technology, Renewable Energy etc.

The undergraduate program of the department offers a unique blend of core and elective courses. The laboratory exercises and mini projects are carefully designed to ensure synchronism with the curriculum, and exposure to relevant Software & Hardware packages related to the field of learning. The curriculum design enables the graduates to embark on a professional career or pursue higher studies in their area of interest.

The department also offers two post – graduate programs ;M.Tech in Energy Systems & Management &M.Tech in Power electronics & drives.The department has well equipped and state of the art laboratories, such as Advanced Energy Systems Lab (sponsored by Schneider Electric), Power Electronics Lab, Solid State & Drives Lab, Lighting Lab. Research and Consultancy takes place in core competency area of the department such as Lighting & Energy Studies, Power & Control Systems, Power Electronics & Drives, Embedded Systems.

Programs offered

Under Graduate Program

- B.Tech in Electrical & Electronics Engineering (1960)

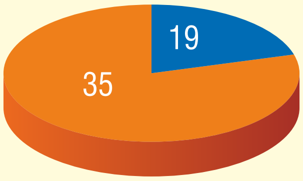
Post Graduate Programs

- M.Tech in Energy Systems & Management (1989)
- M.Tech in Power Electronics & Drives (2008)

PhD

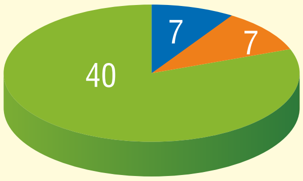
Faculty Strength

Qualification-wise



- PhD
- M.Tech/ME

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, MIT Manipal

M.Tech. ENERGY SYSTEMS AND MANAGEMENT

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5163	Computational Methods and Applied Linear Algebra	4	0	0	4	ELE 5251	Power System Operation and Control	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ELE 5252	Solid State Lighting	4	0	2	5
	ELE 5151	Advanced Energy Management	4	0	2	5	ELE ****	Elective I	4	0	0	4
	ELE 5152	Design of Control Systems	3	1	0	4	ELE ****	Elective II	4	0	0	4
	ELE 5153	Energy Auditing	4	0	2	5	ELE ****	Elective III	4	0	0	4
	ELE 5154	Integrated Lighting Design	4	0	2	5	*** ****	Open Elective	3	0	0	3
							ELE 5263	Energy Systems Lab	0	0	3	1
		Total	**20**	**1**	**9**	**25**		**Total**	**23**	**0**	**5**	**25**
	THIRD AND FOURTH SEMESTER											
II	ELE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
ELE 5001	Digital Signal Processing and Applications	ELE 5007	Energy Storage Devices
ELE 5002	Digital System Design using FPGA	ELE 5008	Instrumentation in Electrical Systems
ELE 5003	Distributed Energy Systems	ELE 5009	Lighting Controls: Technology and Applications
ELE 5004	Electric Vehicles	ELE 5010	Power Quality Issues and Mitigation
ELE 5005	Embedded System Design	ELE 5011	Time Frequency Analysis
ELE 5006	Energy Analytics	ELE 5012	Wind Energy Conversion Systems

OPEN ELECTIVES			
ELE 5051	Intelligent Control Systems	ELE 5052	Photovoltaic Systems

SEMESTER I

MAT 5163 COMPUTATIONAL METHODS & APPLIED LINEAR ALGEBRA [4 0 0 4]

Numerical differentiation and integration, ODE, PDE, Optimization techniques – linear programming, dynamic programming, genetic algorithm, PSO, Linear Algebra - vector space, matrix algebra, simultaneous equations, LU decomposition and matrix inversion, special matrices and Gauss Siedel methods applied in engineering problems, eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, polynomial matrices

References:

1. Steven. C. Chapra and Raymond P. Canale, “Numerical Methods for Engineers”, Tata McGraw Hill Edition, 2006
2. S. S. Sastry, “Numerical Analysis for Engineers” Tata McGraw Hill Edition, 2002
3. Hoffman K and Kunze R, “Linear Algebra”, Prentice Hall of India, 2011.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology - Basic concepts, Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation, Research formulation - Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis - Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications, Data Analysis - Sources of data, Collection of data, Measurement and scaling technique, Data analysis techniques, Thesis Writing and Journal Publication - thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

ELE 5151 ADVANCED ENERGY MANAGEMENT [4 0 2 5]

Introduction to Energy scenario and related policies. Load sharing, Demand Side Management, Tariffs, Custom power devices, Load management. Electrical energy management systems, Operation states of power system, Network analysis functions, State estimation, Power system security, Introduction to Optimal Power Flow. Introduction to SCADA – Hardware, Software protocols, Power system automation, Applications of SCADA, IEC 61850 standard for SCADA, PMUs and applications Laboratory exercises on Energy measurement and management.

References:

1. Handschin, E, Energy Management Systems, Springer Verlag, 1990.
2. Handschin, E, Real Time Control of Electric Power Systems, Elsevier, 1972.
3. John D Mc Donald, Electric Power Substation Engineering, CRC press, 2001.
4. Wood, A. J and Wollenberg, B. F, Power Generation Operation and Control, 2nd Edition John Wiley and Sons, 2003.
5. Green, J. N, Wilson, R, Control and Automation of Electric Power Distribution Systems, Taylor and Francis, 2007.
6. Turner, W. C, Energy Management Handbook, 5th Edition, 2004.
7. Tanuj Kumar Bisht, SCADA and Energy management system, S.K. Kataria & Sons; 2013 edition (2014)

ELE 5152 DESIGN OF CONTROL SYSTEMS [3 1 0 4]

Review of mathematical modeling of mechanical / electrical / electromechanical systems – transfer function and state space approach, System Identification, Lyapunov Stability, Input-Output Stability, Stabilization via state feedback, Absolute stability, Controllability, Observability, Design and realization of active industrial controllers / compensators, Output Feedback Control, Pole Placement Control, Linear Quadratic Regulator, Linear Quadratic Gaussian control, Sliding Mode Control, Optimal Control Theory, Adaptive control theory, Case study.

References:

1. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, Inc, 2010
2. Ogata K, Modern Control Engineering, Englewood Cliffs, NJ: Prentice Hall, 2010
3. Richard C. Dorf, Robert H. Bishop., Modern Control Systems, Pearson, 2011
4. Hassan K. Khalil, Nonlinear Systems, Macmillan, 1992
5. Martin Enqvist, Linear Models of Nonlinear Systems, Department of Electrical Engineering Linköpings universitet, Sweden, elibrary.matf.bg.ac.rs
6. Kemin Zhou, John C. Doyle, Essentials of Robust Control, Prentice Hall, 1999
7. Geir E. Dullerud, Fernando G. Paganini, A Course in Robust Control Theory - a convex approach, Springer 2005
8. William Brogan, Modern Control Theory, Pearson, 1990

ELE 5153 ENERGY AUDITING [4 0 2 5]

Energy Types, Needs & Scenario, Energy Security, Environmental Impact, Energy Reforms & Policies, Government & EESL Programmes - PAT Scheme etc, 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, Project management – Planning, Analysis, Financing, Contract management, Implementation; Green Buildings – Heat Flow calculation in buildings, Passive & Active Strategies, Rating Systems & Compliance, Process Auditing

Lab Exercises: Performance Assessment of Electrical & Mechanical Utilities, Energy Audit of Hostel Building / Academic Building, Building Energy Performance Simulation & Analysis

References:

1. Paul W. O'Callaghan, "Energy Management A comprehensive guide to reducing costs by efficient energy use", McGraw Hill, England, 1992
2. Amit 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".
4. Steve Doty and Wayne C. Turner, "Energy Management Handbook", 7th Edn, Fairmont Press, USA, 2009.
5. BEE Study Material, "Energy Management & Energy Audit", www.beeindia.gov.in
6. LC Witte, PS Schmidt & DR Brown, "Industrial Energy management & Utilization", Hemisphere Publishing Corporation, Washington, 1998
7. W WC Turner and Steve Doty, "Energy Management Handbook", Seventh Edition, (Fairmont Press Inc., 2007)
8. Sumper Andreas and Baggini Angelo, "Electrical Energy Efficiency: Technologies and Applications", John Wiley 2012
9. Frank Kreith, "Handbook on Energy Efficiency and Renewable Energy", CRC Press, 2007

ELE 5154 INTEGRATED LIGHTING DESIGN [4 0 2 5]

Study of visible spectrum and human eye response, photometric quantities and units, types of artificial light sources – their principle of operation, performance characteristics and application, light control elements, colorimetric & photometric measurements of lighting fixtures and mechanical testing, interior and exterior lighting, lighting standards, design using lumen method and simulation packages, daylighting, daylight–artificial light integrated system

Experiments on:

- Photometric measurement using gonio-photometer
- Calorimetric measurement using integrating sphere
- Interior lighting design using simulation package
- Exterior lighting design using simulation package
- Daylighting using simulation package

References:

1. IESNA New York, Lighting Handbook, (10e), 2011
2. Spiros Kitsinelis, Light Sources: Technologies & Applications, CRC press, 2010
3. Robert Karlicek, Handbook of Advanced Lighting Technology, Springer Publications, 2017
4. M.A. Cayless & A.M. Marsdon, Lamps & Lighting, (4e) Oxford & IBH publishing company, 1996
5. Jack L. Lindsey., Applied Illumination Engineering, (2e), Fairmont Press, INC 1997
6. National Lighting Code - 2010

SEMESTER II

ELE 5251 POWER SYSTEM OPERATION AND CONTROL [4 0 0 4]

Review of Power Systems, Modern Power system and its characteristics, operating states, equipment and stability constraints, Generator and Turbine model, Load frequency control, Automatic Generation control, Reactive power control, excitation control, series and shunt reactive compensators, Economic load dispatch, penalty factors, loss coefficients, optimal power flow, unit commitment, computer control of power system, Renewable energy integration and control, data logging.

References:

1. Wood and Wollenberg, "Power Generation Operation & Control", Wiley, 2011.
2. P. Kundur, "Power System Stability and Control", TMH, 2012.
3. O.I Elgerd, "Electric Energy System Theory-An Introduction", TMH, 2003.
4. Mahalanabis, Kothari, Ahson, "Computer aided Power System Analysis and Control", TMH, 1991.
5. Hadi Saadat, "Power System Analysis", TMH, 2004.
6. R. Bergen, Vijay Vital, "Power System Analysis", (2e), Prentice Hall

ELE 5252 SOLID STATE LIGHTING [4 0 2 5]

Introduction to solid state lighting, principle of light generation, Types of LEDs and its characteristics, Colour tunability and white light generation, LED driver considerations and power supply design, LED dimming and control strategies, Thermal management in LED luminaires, Testing standards, Reliability and performance analysis of LED luminaires.

Supported by Laboratory Exercises:

- Characteristics of different coloured LEDs and colour mixing of LEDs.
- Effect of drive current and temperature on performance of LEDs.
- LED power supply design simulations.
- LED thermal management simulations.
- Reliability prediction using secondary data sets

References:

1. W.D. van Driel, Xuejun Fan., "Solid State Lighting Reliability: Components to Systems", Solid State Lighting Technology and Application Series, Springer Publications, 2013. (DOI: 10.1007/978-1-4614-3067-4.)
2. Robert Karlicek, Ching-Cherng Sun, Georges Zissis, Ruiqing Ma., "Handbook of Advanced Lighting Technology", Springer International Publishing, 2017. (DOI: 10.1007/978-3-319-00176-0)
3. Clemens J.M. Lasance, András Poppe., "Thermal Management for LED Applications", Solid State Lighting Technology and Application Series, Springer Publications, 2014. (DOI: 10.1007/978-1-4614-5091-7.)
4. Joseph Shinar., "Organic Light-Emitting Devices", Springer-Verlag New York, 2004. (DOI: 10.1007/978-0-387-21720-8.)
5. References from current literatures

ELE 5263 ENERGY SYSTEMS LAB [0 0 3 1]

Lab exercises on Power and energy systems - Generator modeling, Load frequency control, Automatic Generation control, Series and Shunt reactive compensators, Economic load dispatch, I-V & P-V characteristics of a PV module - effect of varying insolation, tilt, shading, Grid tied PV systems, wind energy systems- power versus wind speed, cut in speed

SEMESTER III & IV

ELE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

ELE 5001 DIGITAL SIGNAL PROCESSING AND APPLICATIONS [4 0 0 4]

Introduction to Signal Processing, Review of DFS and DTFT, Computation of DFT and FFT, Introduction to linear filtering using DFT, Digital Filter Structures - direct form I and II, Cascade, Parallel, Lattice, Linear phase, Digital Filter Design - FIR filter using window function technique and frequency sampling technique, finite word length, IIR filter design with bilinear transformation technique and impulse invariant technique, Architecture of Digital Signal Processors, Application of DSP in Power Electronics Converters and Drives.

References:

1. Proakis J.G. and D.G. Manolakis, Introduction to Digital Signal Processing (4e), PHI, 2007
2. Mitra S. K., DSP: A computer based approach (2e), TMH, 2006
3. Douglas O'Shaghnessy, Speech communication – Human & Machines (2e), Wiley-IEEE Press 1999
4. Gonzalez R. C. & Woods R. E, Digital Image Processing, Pearson, 2005

ELE 5002 DIGITAL SYSTEM DESIGN USING FPGA [4 0 0 4]

Revision of basic Digital systems - Combinational Circuits, Sequential Circuits, Synchronous FSM and asynchronous design, Metastability, Clock distribution and issues, basic building blocks like PWM module, pre-fetch unit, pre-fetch unit, programmable counter, FIFO, Booth's multiplier, ALU, Barrel shifter etc, Digital system Design - Top down Approach to Design, Verilog Synthesis for FPGA Implementation - Verilog constructs and operators, interpretation of Verilog constructs, Examples of Verilog codes for combinational and sequential logic, Data Path and Control Path Design, Programmable Logic Devices - Introduction, Evolution - PROM, PLA, PAL, Architecture of PAL's, Applications, Programming PLD's, FPGA with technology, FPGA structures, Programmable Interconnections, Coarse grained reconfigurable devices, Case study - Applications of digital system design for power electronic converters and drives. IP and Prototyping - IP in various forms: RTL Source code, Encrypted Source code, Soft IP, Netlist, Physical IP, and Use of external hard IP during prototyping, Case studies, and Speed issues, Testing of logic circuits -Fault models, BIST, JTAG interface

References:

1. S. Palnitkar, Verilog HDL : A Guide to Digital Design and Synthesis, PH/Pearson, 2003
2. K. Coffman, Real World FPGA Design with Verilog, PH,1999
3. Peter Ashenden, Digital Design: An Embedded systems Approach using Verilog, Elsevier, 2007
4. Douglas Smith, "HDL Design: A Practical Guide for Designing, Synthesizing & Simulating ASICs & FPGAs Using VHDL or Verilog", Doone publications 1998.

ELE 5003 DISTRIBUTED ENERGY SYSTEMS [4 0 0 4]

Energy scenario,Overview of electrical grid, introduction to distributed generation, sources of DG systems, advantages, sizing and siting of distributed generation and demand side management, power quality issues, voltage stability, storage technology for power smoothing, operation of hybrid DG systems, micro grids, types of grid integration, issues and challenges, principles of power injection, converting technologies for grid integration, AC-link integration, DC-link integration, HFAC-link integration, instantaneous active and reactive power control approach, standards and codes for interconnection, islanding operation, Life cycle costing.

References:

1. H. Lee Willia and W.G Scott, Distributed power Generation Planning and Evaluation, CRC Press,2007
2. Felix. A. Farret, M. Godoy Simoes, Integration of Alternative Sources of Energy, Wiley InterScience, 2008.
3. Extracts from current literature

ELE 5004 ELECTRIC VEHICLES [4 0 0 4]

Introduction to Electric Vehicles - History, social and environmental importance, Impact of modern drive-trains; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, Electric Drive-trains - Basic concepts, power flow control, topologies; Electric Propulsion unit: Introduction, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, Energy Storage - Introduction, Charging technologies, Battery based energy storage, Fuel Cell based energy storage, Super Capacitor based energy storage and Flywheel based energy storage and analysis, Sizing the drive system - Sizing the propulsion motor, power electronics, energy storage technology, Communications, Supporting subsystems - Energy Management Strategies, Battery management systems, Fleet management systems, EV standards, Case Studies - Design of a Battery Electric Vehicle (BEV).

References:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E .Gay, and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press 2004. online access from computers on the colorado.edu network.
2. Evaluation of the 2004 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab 2006 report
3. Evaluation of the 2010 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab 2011 report
4. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2010.
5. C.Mi, M.A.Masrur, D.W.Gao, Hybrid Electric Vehicles, Wiley 2011.

ELE 5005 EMBEDDED SYSTEM DESIGN [4 0 0 4]

Embedded Systems - Introduction, Processor and memory architecture, Embedded hardware, Processor for embedded applications, Processing power and benchmarks, PIC microcontroller, Instruction set, on chip peripherals, ARM processor, ARM instruction set, ARM exceptions, ARM '3' stage pipeline, ARM processor based microcontroller, Memory organization, Cache memory, Virtual memory management, Input and output device interfacing - Parallel and serial interfaces and communication protocols, Wireless communication protocols, Embedded system design - Issues and challenges, Current trends in embedded system design.

References:

1. Frank Vahid and Tony Givargis, Embedded system design, Wiley India, 2012.
2. Shibu K V, Introduction to Embedded Systems, TMH, 2012
3. Steve Furber, ARM System on chip architecture, Pearson, 2012
4. Bose B. K., Microcomputer Control of Power Electronics and Drives, IEEE Press, 1999.
5. Ajay V Deshmukh, Microcontrollers, TMH, 2007

ELE 5006 ENERGY ANALYTICS [4 0 0 4]

Introduction to Data science and Data analytics, Data Sets and relations, Data Preprocessing, Data Modeling and Visualization, Correlation Analysis, Regression Analysis, Forecasting techniques, Classification and clustering techniques, Electricity and Energy management, Industrial and household loads, working and maintenance techniques, Demand side management approaches, Applications of data analytics in energy sector.

References:

1. Thomas A. Runkler, "Data Analytics Models and Algorithms for Intelligent Data Analysis", 2nd Edition, Springer Publications, 2016.
2. John J. McGowan, "Energy and Analytics: Big data and building technology integration", Fairmont Press, 2015.
3. Seog-Chan Oh, Alfred J. Hildreth "Analytics for Smart Energy Management", Springer Series in Advanced Manufacturing, 2016.
4. Kornelis Blok, Evert Nieuwlaar, "Introduction to Energy Analysis", Routledge, 2016.
5. References from current literatures

ELE 5007 ENERGY STORAGE DEVICES [4 0 0 4]

Introduction to different energy forms-Need for Energy storage, performance indices. Mechanical energy storage, Electromagnetic energy storage. Electro-chemical storage- Electro-chemical cell, fuel cells, batteries, Battery Technologies, Fuel cells: History – principle - working - thermodynamics and kinetics of fuel cell process –performance evaluation of fuel cell – comparison on battery Vs fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, Hydrogen storage: Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, carbon based materials for hydrogen storage, hydrogen as storage medium for renewable energy systems, Pumped hydrostorage, Energy Storage Systems & applications – utilities, transport, industry, house hold, total energy system – hybrid, combined, integrated.

References:

1. Johannes Jensen Bent Squrensen, Fundamentals of Energy Storage, John Wiley, NY, 1984.
2. P. Peregrinus, Electrochemical Power Sources: Primary and Secondary Batteries, M. Barak (Editor), IEE, 1980.
3. Baader, W. Dohne, E, Brenndorfer, Bio-gas in Theory and Practice, [Russian translation], Kolos, Moscow, 1982.
4. P.D.Dunn, Renewable Energies, Peter Peregrinus Ltd, London, United Kingdom , 1st Edition, 1986.
5. Sorenson B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005).
6. Hordeski MF, Hydrogen and Fuel Cells: Advances in Transportation and Power, The Fairmont Press, Inc. (2009)
7. Busby RL, Hydrogen and Fuel Cells: A Comprehensive Guide, PennWell Books (2005).

ELE 5008 INSTRUMENTATION IN ELECTRICAL SYSTEMS [4 0 0 4]

Electrical instrumentation: Introduction & Overview, Modern transducers – Resistive, Inductive, Capacitive types, Smart Transducers and Non-Contact Transducers – Modeling and analysis, Analog Signal Conditioning: Active Amplifiers and Filters – Modeling and analysis, signal modulation & demodulation, A/D and D/A converters, Signal Transmission – wired and wireless, Programmable Logic Controllers – Overview of the architecture, Ladder design for typical industrial applications, Virtual Instrumentation – Overview of LabVIEW programming for various applications, Smart Metering, Internet of Things

References:

1. Clarence W. deSilva : Sensors & Actuators: Engineering System Instrumentation, 2nd Edition, CRC Press (Taylor & Francis Group)
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw Hill, 4th Edition - 2014
3. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI
4. David A. Bell: Operational amplifiers & linear ICs, 2nd edition, PHI/Pearson 2004
5. Hank Zumbahlen, "Linear Circuit Design Handbook: Analog Devices" – Elsevier, 2008
6. JR Hackworth and F.D Hackworth Jr: Programmable logic controllers- Programming Method and applications, Pearson, 2004

ELE 5009 LIGHTING CONTROLS: TECHNOLOGY & APPLICATIONS [4 0 0 4]

Strategies and technologies - occupancy sensing, switching controls, daylight adaptation and photo sensors, Commissioning and energy codes, Controller and control algorithms - Integral reset, open-loop and closed loop control, adaptive control, predictive control , inverse control with online adaptive learning, Camera based measurement, virtual scenario based intelligent lighting control, Protocols and Networking - architecture, standard lighting protocols, wired and wireless, centralized and distributed, WSAN lighting control application, connected lighting system, SoC solutions for lighting control system, Low voltage dc systems, Power-over-Ethernet, Commissioning of smart lighting system.

References:

1. Simpson, Robert S. Lighting control: technology and applications. Taylor & Francis, 2003.
2. DiLouie, Craig. Lighting controls handbook. The Fairmont Press, Inc., 2008.
3. Cai, H. "Luminance gradient for evaluating lighting." Lighting Research & Technology 48.2 (2016): 155-175.
4. Serpanos, Dimitrios, and Marilyn Wolf. Internet-of-things (iot) Systems: Architectures, Algorithms, Methodologies. Springer, 2017.
5. Yang, Kun. "Wireless sensor networks." Principles, Design and Applications (2014).

ELE 5010 POWER QUALITY ISSUES & MITIGATION [4 0 0 4]

Power Quality Issues - Terminologies, classification, causes, effects, Power Quality Monitoring - Standards, measurement techniques, PQ monitoring system, Power Quality Mitigation - Analysis and design of passive compensators, PQ enhancement using custom power devices - DSTATCOMs, DVRs, UPQCs, control and design, Power Filters - passive, active and hybrid approaches, control and design, Performance analysis of simple systems through modeling and simulation studies, design of power filters, Power quality improvement in electrical system.

References:

1. Bhim Singh, Ambrish Chandra and Kamal Al Haddad, Power Quality: Problems and Mitigation Techniques, John Wiley & Sons Ltd., U. K, 2015
2. C. Shankaran, Power Quality, CRC Press, 2013.
3. Math H J Bollen, Understanding Power Quality Problems; Voltage Sags and Interruptions, Wiley India, 2011.
4. Roger C Dugan, et.al, Electrical Power Systems Quality, 3rd Edition, TMH, 2012.
5. Arindam Ghosh et.al, Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers, 2002

ELE 5011 TIME FREQUENCY ANALYSIS [4 0 0 4]

The time and frequency description of signals, bandwidth equation, AM and FM contributions to the bandwidth, Fourier transform of the time and frequency densities, non-additivity of spectral properties, uncertainty principle. Instantaneous frequency and the complex signal, analytic signal, quadrature approximation, instantaneous frequency, density of instantaneous frequency, one dimensional densities, two dimensional densities, local quantities, negative densities, Time-Frequency Distributions - global averages, local average, time and frequency shift invariance, linear scaling, weak and strong finite support, uncertainty principle and joint distributions, short-time Fourier transform and spectrogram, global quantities, local averages, optimal window. Wavelet bases for discrete and continuous variables, The Haar basis, Differentiable wavelet bases, Compact wavelet bases, Multiresolution analysis, Applications: Wide Area Measurement

References:

1. L. Cohen, Time-Frequency Analysis. Prentice Hall, 1995.
2. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
3. M. Vetterli, J. Kovacevic, and V. K. Goyal, Fourier and Wavelet Signal Processing. Book site: http://fourierandwavelets.org/terms.php

ELE 5012 WIND ENERGY CONVERSION SYSTEMS [4 0 0 4]

Wind source, wind statistics, energy in the wind, turbine power characteristics - aerodynamics, rotor types, parts of wind turbines, braking systems, tower - control and monitoring system, Types of generators, General characteristics of induction generators – grid-connected and self-excited systems steady state equivalent circuit, performance predetermination, permanent magnet alternator, steady-state performance, Power electronic converters for interfacing wind electric generators, power quality issues, hybrid systems -wind-diesel systems, wind-solar systems, wind-micro turbine systems, wind – fuel cell systems, Wind Energy Application, Wind pumps - Performance analysis, design concept and testing, Principle of Wind Energy Generators, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Wind energy in India, Case studies.

References:

1. Adel, A Elbaset, Renewable Energy and Smart Grid Integration Through Advanced Power Electronics, Elminia University, Elminia, Egypt.
2. Nelon Vaughn, wind energy .CRC press Boca Raton 2009.
3. S.N Bhadra, D.Kastha, S. Banerjee, Wind Electrical system, Oxford university press 2005.

OPEN ELECTIVES

ELE 5051 INTELLIGENT CONTROL SYSTEMS [3 0 0 3]

Fundamentals of Artificial Neural Networks - Feed forward and feedback networks, learning rules, Single layer feed forward networks, Multilayer feed forward networks, Linearly non-separable pattern classification, generalized delta learning rule, error back propagation training algorithms, Single layer feedback network - Energy function, Application of neural networks, Introduction to Fuzzy control, Inference rules, Fuzzy knowledge based controllers, Fuzzification, membership function evaluation, Defuzzification methods, Application of fuzzy logic to control systems, fuzzy-neural systems, Introduction to Genetic Algorithms.

References:

1. J. S. T Jang, C.T Sun and E. Mitzutani, Neuro-Fuzzy and Soft Computing, Prentice Hall International, Inc, 2011.
2. Chin-Teng Lin, C.S.George Lee, Neural Fuzzy Systems, Prentice – Hall International, Inc.1996.
3. S. Haykin, Neural Networks - A Comprehensive Foundation - 2nd Edition, Prentice Hall, 2005.
4. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc., 2014
5. Jacek M. Zurada, Introduction to Artificial Neural Networks, Jaico, 2016

ELE 5052 PHOTOVOLTAIC SYSTEMS [3 0 0 3]

Prerequisites: Basics on solar systems, Electronic devices, Electrical machines and Power electronics.

Basic characteristics of sunlight, Solar PV cell, I-V characteristics, P-V characteristics, fill factor, Modeling of solar cell, maximum power point tracking, PV module, blocking diode and bypass diodes, composite characteristics of PV module, PV array, PV system design, Applications – PV powered fan, PV fan with battery backup and charge controllers, PV powered pumping system, PV powered lighting systems, grid connected PV systems, Simple payback period, life cycle costing.

References:

1. Chetan Singh Solanki, 'Solar Photovoltaic's: Fundamentals, Technologies and Applications' PHI Learning Publications, 2 Nd Edition, 2011.
2. Roger A. Messenger and Jerry Ventre, 'Photovoltaic systems engineering', Taylor and Francis Group Publications, 2nd Edition, 2003.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, MIT Manipal

M.Tech. POWER ELECTRONICS AND DRIVES

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5163	Computational Methods and Applied Linear Algebra	4	0	0	4	ELE 5271	Advanced Power Electronic Converters	4	0	2	5
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ELE 5272	Application of Power Electronics in Power Systems	4	0	2	5
	ELE 5152	Design of Control Systems	3	1	0	4	ELE ****	Elective I	4	0	0	4
	ELE 5171	Embedded System Design	4	0	2	5	ELE ****	Elective II	4	0	0	4
	ELE 5172	Modeling and Analysis of Electrical Machines	4	0	2	5	ELE ****	Elective III	4	0	0	4
	ELE 5173	Power Semiconductor Controlled Drives	4	0	0	4	*** ****	Open Elective	3	0	0	3
	ELE 5161	Electric Drives Lab	0	0	3	1						
		Total	**20**	**1**	**10**	**25**		**Total**	**23**	**0**	**4**	**25**
	THIRD AND FOURTH SEMESTER											
II	ELE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
ELE 5001	Digital Signal Processing and Applications	ELE 5008	Instrumentation in Electrical Systems
ELE 5002	Digital System Design using FPGA	ELE 5009	Lighting Controls: Technology and Applications
ELE 5003	Distributed Energy Systems	ELE 5010	Power Quality Issues and Mitigation
ELE 5004	Electric Vehicles	ELE 5011	Time Frequency Analysis
ELE 5005	Embedded System Design	ELE 5012	Wind Energy Conversion Systems
ELE 5006	Energy Analytics		
ELE 5007	Energy Storage Devices		

OPEN ELECTIVES			
ELE 5051	Intelligent Control Systems	ELE 5052	Photovoltaic Systems

SEMESTER I

MAT 5163 COMPUTATIONAL METHODS & APPLIED LINEAR ALGEBRA [4 1 0 4]

Numerical differentiation and integration, ODE, PDE, Optimization techniques – linear programming, dynamic programming, genetic algorithm, PSO, Linear Algebra - vector space, matrix algebra, simultaneous equations, LU decomposition and matrix inversion, special matrices and Gauss Siedel methods applied in engineering problems, eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, polynomial matrices

References:

1. Steven. C. Chapra and Raymond P. Canale, “Numerical Methods for Engineers”, Tata McGraw Hill Edition, 2006
2. S. S. Sastry, “Numerical Analysis for Engineers” Tata McGraw Hill Edition, 2002
3. Hoffman K and Kunze R, “Linear Algebra”, Prentice Hall of India, 2011.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology - Basic concepts, Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation, Research formulation - Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis - Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications, Data Analysis - Sources of data, Collection of data, Measurement and scaling technique, Data analysis techniques, Thesis Writing and Journal Publication - thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006

ELE 5152 DESIGN OF CONTROL SYSTEMS [3 1 0 4]

Review of mathematical modeling of mechanical / electrical / electromechanical systems – transfer function and state space approach, System Identification, Lyapunov Stability, Input-Output Stability, Stabilization via state feedback, Absolute stability, Controllability, Observability, Design and realization of active industrial controllers / compensators, Output Feedback Control, Pole Placement Control, Linear Quadratic Regulator, Linear Quadratic Gaussian control, Sliding Mode Control, Optimal Control Theory, Adaptive control theory, Case study

References:

1. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, Inc, 2010
2. Ogata K, Modern Control Engineering, Englewood Cliffs, NJ: Prentice Hall, 2010
3. Richard C. Dorf, Robert H. Bishop., Modern Control Systems, Pearson, 2011
4. Hassan K. Khalil, Nonlinear Systems, Macmillan, 1992
5. Martin Enqvist, Linear Models of Nonlinear Systems, Department of Electrical Engineering Linköpings universitet, Sweden, elibrary.matf.bg.ac.rs
6. Kemin Zhou, John C. Doyle, Essentials of Robust Control, Prentice Hall, 1999
7. Geir E. Dullerud, Fernando G. Paganini, A Course in Robust Control Theory - a convex approach, Springer 2005
8. William Brogan, Modern Control Theory, Pearson, 1990

ELE 5171 EMBEDDED SYSTEM DESIGN [4 0 2 5]

Embedded Systems - Introduction, Processor and memory architecture, Embedded hardware, Processor for embedded applications, Processing power and benchmarks, PIC microcontroller, Instruction set, on chip peripherals, ARM processor, ARM instruction set, ARM exceptions, ARM '3' stage pipeline, ARM processor based microcontroller, Memory organization, Cache memory, Virtual memory management, Input and output device interfacing - Parallel and serial interfaces and communication protocols, Wireless communication protocols, Embedded system design - Issues and challenges, Current trends in embedded system design, Introduction to RTOS and Task Scheduling.

Laboratory exercises and application case studies on power factor improvement, power quality measurement, control of electric drives, solar power MPPT.

References:

1. Frank Vahid and Tony Givargis, Embedded system design, Wiley India, 2012.
2. Shibu K V, Introduction to Embedded Systems, TMH, 2012
3. Steve Furber, ARM System on chip architecture, Pearson, 2012
4. Bose B. K., Microcomputer Control of Power Electronics and Drives, IEEE Press, 1999.
5. Ajay V Deshmukh, Microcontrollers, TMH, 2007

ELE 5172 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES [4 0 2 5]

Basics of magnetic circuits, Analysis of magnetic circuits with air gap and permanent magnets, Analysis of singly excited electromechanical system with linear magnetics, nonlinear magnetics using energy and co-energy principles. Inductances of distributed windings - salient pole, cylindrical rotor, Analysis of the doubly excited two-phase rotational system, Reference frames power invariance and non-power invariance, Derivation of dc machine systems from the generalized machine, Analysis of induction machine - synchronous reference frame - with currents as variables - with rotor flux as variables. Basis for vector control - small signal modelling of induction machine, Analysis of the alternator - synchronous reference frame, Derivation of salient and cylindrical rotor machine phasor diagrams. Three phase short circuit of alternator and various time constants.

Lab (Simulation) Exercises on startup transient in DC motor, transients in Induction motor, small signal model of DC and Induction machine, inverter fed Induction motor, slip test of salient pole alternator.

References:

1. Fitzgerald and Kingsley, Electric Machinery (7 ed) McGraw-Hill Higher Education, 2013
2. O'Simmons and Kelly, Introduction to Generalized Machine Theory. McGraw-Hill Higher Education
3. Hancock, Matrix Analysis of Electric Machinery (2 ed) Pergamon Press, 2016
4. Dr. Krishna Vasudevan,IIT, Madras, Modelling and Analysis of Electric Machines https://nptel.ac.in/courses/108106023/

ELE 5173 POWER SEMICONDUCTOR CONTROLLED DRIVES [4 0 0 4]

Components of electric drive system - Types of loads, load characteristics, choice of power modulators, choice of motors, open & closed loop operation of drives, Analysis of converter fed DC motor Drives (single & three phases), Controlled Freewheeling, Analysis of Chopper fed DC motor Drives - single, two and four quadrant operations, AC Drives - Induction motor drives - Stator voltage control, Slip power recovery scheme, Frequency control (Scalar control), Field-oriented control (Vector control), Direct & Indirect, Direct Torque Control (DTC), Synchronous motor drive - Types of synchronous motors, Scalar & Vector control schemes for different types of synchronous motors. Modern trends in industrial drives and control, Case studies relating to steel mills, paper mills, textile mills, machine tools etc, A.C. motor drives in transportation system and traction.

References:

1. Dubey G.K., Fundamentals of Electric Drives, Narosa, 2010.
2. Murphy J.M.D.& F.G.Turnbull, Power Electronic Control of AC motors Pergamon 1989
3. Dubey G.K., Power Semiconductor Controlled Drives, PH, 1989.
4. Dewan S.B., G.R.Slemon & A.Straughen, Power Semiconductor Drives. Wiley, 1984
5. Bose B.K., Modern Power Electronics and AC Drives, Pearson, 2010
6. Krishnan R., Electric Motor Drives: Modeling, Analysis, and Control, Pearson, 2011.
7. Prof. K R Rajagopal, IIT Delhi, Industrial Drives, http://www.nptel.iitm.ac.in/courses
8. Prof K Gopakumar, IISC Bangalore, Industrial Drives-Power electronics, http://www.nptel.iitm.ac.in/courses

ELE 5161 ELECTRIC DRIVES LAB [0 0 3 1]

Simulation Exercises on DC and AC drives, Implementation of PWM controllers on analog / digital controllers, Hardware exercises on DC and AC drives.

SEMESTER II

ELE 5271 ADVANCED POWER ELECTRONIC CONVERTERS [4 0 2 5]

Linear and switched mode power supply – comparison, Design and analysis of non-isolated dc-dc converters - Buck, Boost, Buck-Boost, Cuk, SEPIC, Effect of non-idealities on the performance of converters, Isolated dc-dc converter topologies - Design and analysis of Fly-back, Forward, Push-Pull, Half-bridge and full-bridge configurations, Design of Magnetics - Inductor and transformer design for high frequency applications, Resonant Converters – Loaded resonant converters, SLRs and PLRs – analysis and design issues, ZCS, ZVS, ZCT, ZVT, Converter dynamics and control, converter transfer functions, regulator design, current mode control, slope compensation technique, unity power factor converter, Applications – MPPT, Solid State lighting

Lab Exercise:

Simulation exercise on isolated and non-isolated converter topologies, Design of high frequency inductor, Simulation exercise on soft switched converters, hardware realization of non-isolated / isolated converter.

References:

1. Robert W. Erickson, Dragan Maksimovic; Fundamentals of Power Electronics, (2 ed), Springer, 2005
2. Mohan, Undeland & Robbins; Power Electronics, Converters, Applications and Design, Wiley-2001
3. Daniel.W. Hart, Introduction to Power Electronics by, PHI-1997 edition
4. Umanand L, Bhat S.R, “Design of magnetic components for switched mode power converters”, New age International limited, 2001.
5. P. Krein, Elements of Power electronics, OUP, 1998
6. Prof. Umanand and Prof. Ramanarayanan, IISc Bangalore, Switched Mode Power Conversion: http://nptel.ac.in/courses/108108036/

ELE 5272 APPLICATION OF POWER ELECTRONICS IN POWER SYSTEMS [4 0 2 5]

Introduction to FACTS controllers - configuration and working principle of SVC, STATCOM, TCSC, SSSC, SPS and UPF Steady state characteristics, effect of FACTS devices on transient stability, power flow, power oscillation damping and voltage stability. Definition of Power Quality, issues, fundamentals of load compensation, control theories for load compensation, harmonic filters, DSTATCOM, DVR and UPQC circuit, operation, control modes. 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.

Laboratory exercises on performance of uncompensated and compensated transmission line, stability analysis of the system with FACTS controllers, mitigation of harmonics by passive and active filters, performance analysis of custom power devices, modelling of HVDC systems.

References:

1. N.G. Hingorani & Laszlo Gyugyi, 'Understanding FACTS', IEEE press, Wiley Interscience, 2000.
2. K.R. Padiyar 'FACTS controllers in power transmission and distribution', New Age International Publisher, 2008.
3. R. Mohan Mathur and Rajiv K Varma, 'Thyristor based FACTS controllers for Electrical Transmission systems', IEEE press, Wiley Interscience, 2002.
4. Ewald F. Fuchs & Mohammad A.S. Masoum, 'Power Quality in Power

Systems and Electrical Machines', Elsevier Academic Press 2008.
5. Vijay K Sood, 'HVDC and FACTS controllers', Kluwer Academic Publishers, 2004.
6. J. Arrillaga, N. R. Watson, S. Chen, 'Power System Quality Assessment', John Wiley & Sons, England, 2000.

SEMESTER III & IV

ELE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

ELE 5001 DIGITAL SIGNAL PROCESSING AND APPLICATIONS [4 0 0 4]

Introduction to Signal Processing, Review of DFS and DTFT, Computation of DFT and FFT, Introduction to linear filtering using DFT, Digital Filter Structures - direct form I and II, Cascade, Parallel, Lattice, Linear phase, Digital Filter Design - FIR filter using window function technique and frequency sampling technique, finite word length, IIR filter design with bilinear transformation technique and impulse invariant technique, Architecture of Digital Signal Processors, Application of DSP in Power Electronics Converters and Drives.

References:

1. Proakis J.G. and D.G. Manolakis, Introduction to Digital Signal Processing (4e), PHI, 2007
2. Mitra S. K., DSP: A computer based approach (2e), TMH, 2006
3. Douglas O'Shaghnessy, Speech communication – Human & Machines (2e), Wiley-IEEE Press 1999 Gonzalez R. C. & Woods R. E, Digital Image Processing, Pearson, 2005

ELE 5002 DIGITAL SYSTEM DESIGN USING FPGA [4 0 0 4]

Revision of basic Digital systems-Combinational Circuits, Sequential Circuits, Synchronous FSM and asynchronous design, Metastability, Clock distribution and issues, basic building blocks like PWM module, pre-fetch unit, pre-fetch unit, programmable counter, FIFO, Booth's multiplier, ALU, Barrel shifter etc, Digital system Design - Top down Approach to Design, Verilog Synthesis for FPGA Implementation - Verilog constructs and operators, interpretation of Verilog constructs, Examples of Verilog codes for combinational and sequential logic, Data Path and Control Path Design, Programmable Logic Devices - Introduction, Evolution - PROM, PLA, PAL, Architecture of PAL's, Applications, Programming PLD's, FPGA with technology, FPGA structures, Programmable Interconnections, Coarse grained reconfigurable devices, Case study - Applications of digital system design for power electronic converters and drives. IP and Prototyping - IP in various forms: RTL Source code, Encrypted Source code, Soft IP, Netlist, Physical IP, and Use of external hard IP during prototyping, Case studies, and Speed issues, Testing of logic circuits -Fault models, BIST, JTAG interface

References:

1. S. Palnitkar, Verilog HDL : A Guide to Digital Design and Synthesis, PH/Pearson, 2003
2. K. Coffman, Real World FPGA Design with Verilog, PH,1999
3. Peter Ashenden, Digital Design: An Embedded systems Approach using Verilog, Elsevier, 2007
4. Douglas Smith, “HDL Design: A Practical Guide for Designing, Synthesizing & Simulating ASICs & FPGAs Using VHDL or Verilog”, Doone publications 1998.

ELE 5003 DISTRIBUTED ENERGY SYSTEMS [4 0 0 4]

Energy scenario,Overview of electrical grid, introduction to distributed generation, sources of DG systems, advantages, sizing and siting of distributed generation and demand side management, power quality issues, voltage stability, storage technology for power smoothing, operation of hybrid DG systems, micro grids, types of grid integration, issues and challenges, principles of power injection, converting technologies for grid integration, AC-link integration, DC-link integration, HFAC-link integration, instantaneous active and reactive power control approach, standards and codes for interconnection, islanding operation, Life cycle costing.

References:

1. H. Lee Willia and W.G Scott, Distributed power Generation Planning and Evaluation, CRC Press,2007
2. Felix. A. Farret, M. Godoy Simoes, Integration of Alternative Sources of Energy, Wiley InterScience, 2008.
3. Extracts from current literature

ELE 5004 ELECTRIC VEHICLES [4 0 0 4]

Introduction to Electric Vehicles - History, social and environmental importance, Impact of modern drive-trains; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, Electric Drive-trains - Basic concepts, power flow control, topologies; Electric Propulsion unit: Introduction, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, Energy Storage - Introduction, Charging technologies, Battery based energy storage, Fuel Cell based energy storage, Super Capacitor based energy storage and Flywheel based energy storage and analysis, Sizing the drive system - Sizing the propulsion motor, power electronics, energy storage technology, Communications, Supporting subsystems - Energy Management Strategies, Battery management systems, Fleet management systems, EV standards, Case Studies - Design of a Battery Electric Vehicle (BEV)

References:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E .Gay, and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press 2004. online access from computers on the colorado.edu network.
2. Evaluation of the 2004 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab 2006 report
3. Evaluation of the 2010 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab 2011 report
4. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2010.
5. C.Mi, M.A.Masrur, D.W.Gao, Hybrid Electric Vehicles, Wiley 2011.

ELE 5005 EMBEDDED SYSTEM DESIGN [4 0 0 4]

Embedded Systems - Introduction, Processor and memory architecture, Embedded hardware, Processor for embedded applications, Processing power and benchmarks, PIC microcontroller, Instruction set, on chip peripherals, ARM processor, ARM instruction set, ARM exceptions, ARM '3' stage pipeline, ARM processor based microcontroller, Memory organization, Cache memory, Virtual memory management, Input and output device interfacing - Parallel and serial interfaces and communication protocols, Wireless communication protocols, Embedded system design - Issues and challenges, Current trends in embedded system design.

References:

1. Frank Vahid and Tony Givargis, Embedded system design, Wiley India, 2012.
2. Shibu K V, Introduction to Embedded Systems, TMH, 2012
3. Steve Furber, ARM System on chip architecture, Pearson, 2012
4. Bose B. K., Microcomputer Control of Power Electronics and Drives, IEEE Press, 1999.
5. Ajay V Deshmukh, Microcontrollers, TMH, 2007.

ELE 5006 ENERGY ANALYTICS [4 0 0 4]

Introduction to Data science and Data analytics, Data Sets and relations, Data Preprocessing, Data Modeling and Visualization, Correlation Analysis, Regression Analysis, Forecasting techniques, Classification and clustering techniques, Electricity and Energy management, Industrial and household loads, working and maintenance techniques, Demand side management approaches, Applications of data analytics in energy sector.

References:

1. Thomas A. Runkler, "Data Analytics Models and Algorithms for Intelligent Data Analysis", 2nd Edition, Springer Publications, 2016.
2. John J. McGowan, "Energy and Analytics: Big data and building technology integration", Fairmont Press, 2015.
3. Seog-Chan Oh, Alfred J. Hildreth "Analytics for Smart Energy Management", Springer Series in Advanced Manufacturing, 2016.
4. Kornelis Blok, Evert Nieuwlaar, "Introduction to Energy Analysis", Routledge, 2016.
5. References from current literatures

ELE 5007 ENERGY STORAGE DEVICES [4 0 0 4]

Introduction to different energy forms-Need for Energy storage, performance indices. Mechanical energy storage, Electromagnetic energy storage. Electro-chemical storage- Electro-chemical cell, fuel cells, batteries, Battery Technologies, Fuel cells: History – principle - working - thermodynamics and kinetics of fuel cell process –performance evaluation of fuel cell – comparison on battery Vs fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, Hydrogen storage: Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, carbon based materials for hydrogen storage, hydrogen as storage medium for renewable energy systems, Pumped hydrostorage, Energy Storage Systems & applications – utilities, transport, industry, house hold, total energy system – hybrid, combined, integrated.

References:

1. Johannes Jensen Bent Squrensen, Fundamentals of Energy Storage, John Wiley, NY, 1984.
2. P. Peregrinus, Electrochemical Power Sources: Primary and Secondary Batteries, M. Barak (Editor), IEE, 1980.
3. Baader, W. Dohne, E, Brenndorfer, Bio-gas in Theory and Practice, [Russian translation], Kolos, Moscow, 1982.
4. P.D.Dunn, Renewable Energies, Peter Peregrinus Ltd, London, United Kingdom , 1st Edition, 1986.
5. Sorenson B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005).
6. Hordeski MF, Hydrogen and Fuel Cells: Advances in Transportation and Power, The Fairmont Press, Inc. (2009)
7. Busby RL, Hydrogen and Fuel Cells: A Comprehensive Guide, PennWell Books (2005).

ELE 5008 INSTRUMENTATION IN ELECTRICAL SYSTEMS [4 0 0 4]

Electrical instrumentation: Introduction & Overview, Modern transducers – Resistive, Inductive, Capacitive types, Smart Transducers and Non-Contact Transducers – Modeling and analysis, Analog Signal Conditioning: Active Amplifiers and Filters – Modeling and analysis, signal modulation & demodulation, A/D and D/A converters, Signal Transmission – wired and wireless, Programmable Logic Controllers – Overview of the architecture, Ladder design for typical industrial applications, Virtual Instrumentation – Overview of LabVIEW programming for various applications, Smart Metering, Internet of Things

References:

1. Clarence W. deSilva : Sensors & Actuators: Engineering System Instrumentation, 2nd Edition, CRC Press (Taylor & Francis Group)
2. Sergio Franco,"Design with Operational Amplifiers and Analog Integrated Circuits", McGraw Hill, 4th Edition - 2014
3. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI
4. David A. Bell: Operational amplifiers & linear ICs, 2nd edition, PHI/Pearson 2004
5. Hank Zumbahlen, "Linear Circuit Design Handbook: Analog Devices" – Elsevier, 2008
6. JR Hackworth and F.D Hackworth Jr: Programmable logic controllers- Programming Method and applications, Pearson, 2004

ELE 5009 LIGHTING CONTROLS: TECHNOLOGY & APPLICATIONS [4 0 0 4]

Strategies and technologies - occupancy sensing, switching controls, daylight adaptation and photo sensors, Commissioning and energy codes, Controller and control algorithms - Integral reset, open-loop and closed loop control, adaptive control, predictive control , inverse control with online adaptive learning, Camera based measurement, virtual scenario based intelligent lighting control, Protocols and Networking - architecture, standard lighting protocols, wired and wireless, centralized and distributed, WSAN lighting control application, connected lighting system, SoC solutions for lighting control system, Low voltage dc systems, Power-over-Ethernet, Commissioning of smart lighting system.

References:

1. Simpson, Robert S. Lighting control: technology and applications. Taylor & Francis, 2003.
2. DiLouie, Craig. Lighting controls handbook. The Fairmont Press, Inc., 2008.
3. Cai, H. "Luminance gradient for evaluating lighting." Lighting Research & Technology 48.2 (2016): 155-175.
4. Serpanos, Dimitrios, and Marilyn Wolf. Internet-of-things (iot) Systems: Architectures, Algorithms, Methodologies. Springer, 2017.
5. Yang, Kun. "Wireless sensor networks." Principles, Design and Applications (2014)

ELE 5010 POWER QUALITY ISSUES & MITIGATION [4 0 0 4]

Power Quality Issues - Terminologies, classification, causes, effects, Power Quality Monitoring - Standards, measurement techniques, PQ monitoring system, Power Quality Mitigation - Analysis and design of passive compensators, PQ enhancement using custom power devices - DSTATCOMs, DVRs, UPQCs, control and design, Power Filters - passive, active and hybrid approaches, control and design, Performance analysis of simple systems through modeling and simulation studies, design of power filters, Power quality improvement in electrical system.

References:

1. Bhim Singh, Ambrish Chandra and Kamal Al Haddad, Power Quality: Problems and Mitigation Techniques, John Wiley & Sons Ltd., U. K, 2015
2. C. Shankaran, Power Quality, CRC Press, 2013.
3. Math H J Bollen, Understanding Power Quality Problems; Voltage Sags and Interruptions, Wiley India, 2011.
4. Roger C Dugan, et.al, Electrical Power Systems Quality, 3rd Edition, TMH, 2012.
5. Arindam Ghosh et.al, Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers, 2002

ELE 5011 TIME FREQUENCY ANALYSIS [4 0 0 4]

The time and frequency description of signals, bandwidth equation, AM and FM contributions to the bandwidth, Fourier transform of the time and frequency densities, non-additivity of spectral properties, uncertainty principle. Instantaneous frequency and the complex signal, analytic signal, quadrature approximation, instantaneous frequency, density of instantaneous frequency, one dimensional densities, two dimensional densities, local quantities, negative densities, Time-Frequency Distributions - global averages, local average, time and frequency shift invariance, linear scaling, weak and strong finite support, uncertainty principle and joint distributions, short-time Fourier transform and spectrogram, global quantities, local averages, optimal window. Wavelet bases for discrete and continuous variables, The Haar basis, Differentiable wavelet bases, Compact wavelet bases, Multiresolution analysis, Applications: Wide Area Measurement

References:

1. L. Cohen, Time-Frequency Analysis. Prentice Hall, 1995.
2. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
3. M. Vetterli, J. Kovacevic, and V. K. Goyal, Fourier and Wavelet Signal Processing. Book site: http://fourierandwavelets.org/terms.php

ELE 5012 WIND ENERGY CONVERSION SYSTEMS [4 0 0 4]

Wind source, wind statistics, energy in the wind, turbine power characteristics - aerodynamics, rotor types, parts of wind turbines, braking systems, tower - control and monitoring system, Types of generators, General characteristics of induction generators – grid-connected and self-excited systems steady state equivalent circuit, performance predetermination, permanent magnet alternator, steady-state performance, Power electronic converters for interfacing wind electric generators, power quality issues, hybrid systems -wind-diesel systems, wind-solar systems, wind-micro turbine systems, wind – fuel cell systems, Wind Energy Application, Wind pumps - Performance analysis, design concept and testing, Principle of Wind Energy Generators, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Wind energy in India, Case studies.

References:

1. Adel, A Elbaset, Renewable Energy and Smart Grid Integration Through Advanced Power Electronics, Elminia University, Elminia, Egypt.
2. Nelon Vaughn, wind energy .CRC press Boca Raton 2009.
3. S.N Bhadra, D.Kastha, S. Banerjee, Wind Electrical system, Oxford university press 2005.

OPEN ELECTIVES

ELE 5051 INTELLIGENT CONTROL SYSTEMS [3 0 0 3]

Fundamentals of Artificial Neural Networks - Feed forward and feedback networks, learning rules, Single layer feed forward networks, Multilayer feed forward networks, Linearly non-separable pattern classification, generalized delta learning rule, error back propagation training algorithms, Single layer feedback network - Energy function, Application of neural networks, Introduction to Fuzzy control, Inference rules, Fuzzy knowledge based controllers, Fuzzification, membership function evaluation, Defuzzification methods, Application of fuzzy logic to control systems, fuzzy-neural systems, Introduction to Genetic Algorithms.

References:

1. J. S. T Jang, C.T Sun and E. Mitzutani, Neuro-Fuzzy and Soft Computing, Prentice Hall International, Inc, 2011.
2. Chin-Teng Lin, C.S.George Lee, Neural Fuzzy Systems, Prentice – Hall International, Inc.1996.
3. S. Haykin, Neural Networks - A Comprehensive Foundation - 2nd Edition, Prentice Hall, 2005.
4. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc., 2014
5. Jacek M. Zurada, Introduction to Artificial Neural Networks, Jaico, 2016

ELE 5052 PHOTOVOLTAIC SYSTEMS [3 0 0 3]

Prerequisites: Basics on solar systems, Electronic devices, Electrical machines and Power electronics.

Basic characteristics of sunlight, Solar PV cell, I-V characteristics, P-V characteristics, fill factor, Modeling of solar cell, maximum power point tracking, PV module, blocking diode and bypass diodes, composite characteristics of PV module, PV array, PV system design, Applications – PV powered fan, PV fan with battery backup and charge controllers, PV powered pumping system, PV powered lighting systems, grid connected PV systems, Simple payback period, life cycle costing.

References:

1. Chetan Singh Solanki, 'Solar Photovoltaic's: Fundamentals, Technologies and Applications' PHI Learning Publications, 2 Nd Edition, 2011.
2. Roger A. Messenger and Jerry Ventre, 'Photovoltaic systems engineering', Taylor and Francis Group Publications, 2nd Edition, 2003.

Department of Electronics & Communication Engineering

Established in the year 1972, the department of Electronics & Communication Engineering has developed itself as a center of excellence in academics and research. The department has been working primarily on imparting basic knowledge and essential skills in Electronics and Communication Engineering to the students.

The department has facilities such as MEMS design center for device simulation, fabrication and testing; ATMEL MCU Center; NOVOTON ARM Processor boards; development boards for embedded system; campus wide license for MathWorks tool; and CADENCE tool for VLSI design. To support the co-curricular and extra-curricular activities, at the department level we have IE, IEEE, ISTE student chapters.

In addition to regular teaching learning activity, faculty and student are involved in active research in the area of Image, Audio, and Speech Processing; Biomedical Instrumentation; Soft Computing Techniques; Source and Channel Coding; Cipher System; Sensor Networks; Plasmonics; Analog and Digital VLSI; Embedded Systems; MEMS and Nano technology, Carbon Nano Tubes, and Thin Film Technology. Student research and project work in these domains has resulted in Journal and Conference publications at National and International levels; and has brought laurels at national and International level technical competitions. About 60 to 70 students from every passing out batch go abroad for their masters in reputed universities.

Programs offered

Under Graduate Program

- B.Tech in Electronics and Communication Engineering (1972)

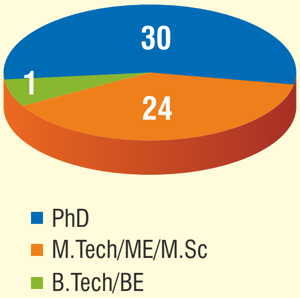
Post Graduate Programs

- M.Tech in Digital Electronics & Communication (1999)
- M.Tech in Microelectronics (2008)

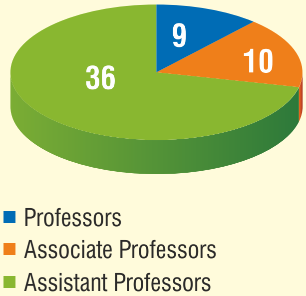
PhD

Faculty Strength

Qualification-wise



Cadre-wise



DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING, MIT Manipal

M.Tech. MICROELECTRONICS

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5151	Probability, Random Variables and Stochastic Processes	4	0	0	4	ECE 5271	CMOS Mixed Signal Design	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ECE 5273	Low Power VLSI Design	4	0	0	4
	ECE 5152	Digital VLSI Design	4	0	0	4	ECE ****	Elective I	4	0	0	4
	ECE 5154	Processor Architecture and Applications	4	0	0	4	ECE ****	Elective II	4	0	0	4
	ECE 5171	Analog and RF VLSI Design	4	0	0	4	ECE ****	Elective III	4	0	0	4
	ECE 5172	Semiconductor Process Technology	4	0	0	4	*** ****	Open Elective	3	0	0	3
	ECE 5163	Analog and RF VLSI Lab	0	0	3	1	ECE 5261	Research Lab	0	0	6	2
	ECE 5164	Microelectronics Lab	0	0	6	2						
		Total	**21**	**0**	**12**	**25**		**Total**	**23**	**0**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	ECE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES

ECE 5001	Advanced Digital Signal Processing	ECE 5010	Digital Speech Processing	ECE 5019	Radar Systems
ECE 5002	Advances in Circuit Elements	ECE 5011	Embedded System Design	ECE 5020	RF Microelectronics Chip Design
ECE 5003	Analog VLSI for Signal Processing	ECE 5012	High Speed Digital Design	ECE 5021	Semiconductor Device Physics
ECE 5004	CAD Tools for VLSI	ECE 5013	Large Area Micro Electronics	ECE 5022	Spread Spectrum Communication
ECE 5005	Coding Theory	ECE 5014	Mems Technology	ECE 5023	System On Chip Design
ECE 5006	Cryptography and Network Security	ECE 5015	Microwave and Millimeter Wave Antenna	ECE 5024	Time-Frequency and Wavelet Transforms
ECE 5007	Data Compression	ECE 5016	Nanophotonics	ECE 5025	VLSI Physical Design and Verification
ECE 5008	Detection and Estimation Theory	ECE 5017	Nonlinear Fiber Optics	ECE 5026	VLSI Testing and Testability
ECE 5009	Digital Image Processing	ECE 5018	Quantum Information Science	ECE 5027	Printed Electronics

OPEN ELECTIVES

ECE 5051	ARM Processor and Applications	ECE 5053	Neural Networks and Fuzzy Logic
ECE 5052	Nanoelectronics		

SEMESTER I

MAT 5151 PROBABILITY, RANDOM VARIABLES AND STOCHASTIC PROCESSES [4 0 0 4]

Statistical Inference: Random Sampling, Sampling distributions, Parameter Estimation and Hypothesis Testing, Regression, Correlation and Analysis of Variance - Examples.
Static probabilities, Dynamic probability. Classification of states, chains of Markov process. Stability of Markov systems, limiting behavior, random walk.
Poisson Processes: assumptions and derivations, related distributions, birth and death processes. Queuing System, general concepts, Model M/M/1 and M/M/S, steady state behavior, transient behavior.

References:

1. Hogg & Craig (1975), “Introduction to Mathematical Statistics”, 4thEdn., MacMillan,
2. J.Medhi, “Stochastic Processes”.
3. A. Papoulis and S. U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
4. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

ECE 5152 DIGITAL VLSI DESIGN [4 0 0 4]

MOS Transistor theory, Inverters, Digital circuit design, VLSI Fabrication and Layouts, CMOS/Bulk technology, SOI technology. Basic circuit concepts and performance estimation: Design Margins and Reliability; Pseudo-NMOS circuits, Dynamic CMOS logic, Domino CMOS structure and design, CCMOS, BiCMOS; Subsystems and Building Blocks; Semiconductor memories. Interconnects in VLSI

References:

1. Neil Weste and K. Eshragian, Principles of CMOS VLSI Design: A System Perspective, Pearson Education, 2000.
2. Jan M, Rabaey, et al, Digital Integrated Circuits: A Design Perspective, Prentice Hall, 2003.
3. Wayne, Wolf, Modern VLSI design: System on Silicon Pearson Education, 2005.
4. Sung, Mo Kang and Yosuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, TMH, 2003
5. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design PHI, 2005.

ECE 5154 PROCESSOR ARCHITECTURE AND APPLICATIONS [4 0 0 4]

Processor Data Path and Control, Pipelining, pipeline hazards, Memory hierarchy, Memory and I/O interface, multiprocessors, parallel processors, performance, Digital Signal Processors, architecture and applications.

References:

1. David A.Patterson & John L.Hennessy, Computer Organization and Design-The Hardware/Software Interface, Third Edition, Elsevier, 2005
2. John L.Hennessy and David A.Patterson, Computer Architecture-A Quantitative Approach, Fourth Edition, Elsevier,2007
3. Phil Lapsley, DSP Processor Fundamentals, IEEE Press, 1997
4. Sen M. Kuo, Woon-Seng Gan Digital Signal Processors, Pearson, 2005
5. Andrew N.Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Elsevier, 2004

ECE 5171 ANALOG AND RF VLSI DESIGN [4 0 0 4]

Review of MOS device, Second-order effect, Long-channel and short-channel devices, Low-frequency and high-frequency MOS models, Noise, Analog Design flow, Design issues, Current sources and sinks; CMOS Amplifiers; Operational Trans conductance Amplifiers(OTA). Analog Layout considerations, CMOS RF Circuit Design, Frequency Synthesizers; Layout considerations for Analog and RF

References:

1. Behzad Razavi,:Design of Analog CMOS Integrated Circuits, 2nd edition, Tata McGraw-Hill, 2017.
2. David A. Johns, Ken Martin, :Analog Integrated Circuit Design, 2nd edition, Johns Wiley & Sons, 2013.
3. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS circuit design,

Layout, and Simulation, 3rd edition, IEEE Press, PHI Pvt. Ltd, 2010.
4. Phillip. E. Allen, and Douglas R. Holberg, CMOS Analog Circuit Design, 3rdedition, Oxford University Press, 2012.
5. BehzadRazavi, RF Microelectronics, 2nd edition, Prentice Hall, 2011.
6. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, Cambridge University Press, 2004.

ECE 5172 SEMICONDUCTOR PROCESS TECHNOLOGY [4 0 0 4]

Material Properties; Crystal Growth; Silicon Oxidation; Kinetics of Growth, Deal-Grove Model, Next generation lithography; Diffusion, ion stopping and channeling; etching. Realizing resistor, capacitor, diode, BJT, MOSFET, CMOS structures, Twin Tub process, High-k Dielectrics, electro-migration. Single and Double Damascene process. IC assembly techniques. Statistical Process Control and Process Monitoring in Semiconductor Fabrication

References:

1. Stephen A. Campbell, The Science & Engineering of Microelectronic Fabrication, Second Edition, Oxford University Press, 2005.
2. Gary S. May and S. M. Sze, Fundamentals of Semiconductor Fabrication, Wiley Student edition, 2004.
3. James D. Plummer, Michael D. Deal and Peter B. Griffin Silicon VLSI Technology: Fundamentals, Practice and Modeling, Pearson, 2000.
4. S.K. Gandhi, VLSI Fabrication Principles, John Wiley & Sons, 1983.
5. S. M. Sze, VLSI Technology, Second Edition, McGraw Hill, 1988.

ECE 5163 ANALOG AND RF VLSI LAB [0 0 3 1]

Design and simulation of analog circuits using Cadence software: High performance current mirror circuits, Amplifiers, OTA, Gibert cell.

Design and simulation of RF blocks using Cadence software: RF continuous-time filters, RF mixer, Quadrature oscillator, RF oscillator, VCO, RF power amplifier

ECE 5164 MICROELECTRONICS LABORATORY [0 0 6 2]

Experiments using cadence software: Digital VLSI design, Simulation using NC launch tool, Design synthesis using RTL compiler, SOC encounter tool for physical design. Identify a research problem and develop a mini-project

SEMESTER II

ECE 5271 CMOS MIXED SIGNAL DESIGN [4 0 0 4]

Analog and Mixed-mode Building Blocks; current mode circuit design; Discrete-time Filters; Continuous-time (CT) Filters; Data Converters; Analog circuits for Sensor Interfacing Applications; Mixed Signal Layout Issues

References:

1. R. Jacob Baker, CMOS: Mixed-Signal Circuit Design, Volume II, Wiley, 2002.
2. Rudy van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Springer, 2003.
3. P. V. Anand Mohan, Current-mode VLSI Analog Filters: Design and Applications , Birkhauser, 2003.
4. T Deliyanis, Y Sun and J K Fidler, Continuos-Time Active Filter Design, CRC Press, 1999.
5. De Marcellis, Andrea, Ferri, Giuseppe, Analog Circuits and Systems for Voltage-Mode and Current-Mode Sensor Interfacing Applications, Analog Circuits and Signal Processing series, Springer, 2011.

ECE 5273 LOW POWER VLSI DESIGN [4 0 0 4]

Sources of power dissipation. Hierarchical Low Power Design Methodologies. probabilistic power analysis; Architecture Level Power reduction techniques; Switching activity reduction techniques; Interconnect Power; Static Power reduction technique; Low power Clock Distribution; System level power reduction techniques

References:

1. Gary K. Yeap, Practical Low Power Digital VLSI Design, KAP, 2002.
2. Christian Piguet, Low-Power CMOS Circuits: Technology, Logic Design and CAD Tools, CRC press, 2005
3. Kaushik Roy, Sharat Prasad, Low Power CMOS VLSI Circuit Design Wiley, 2000.
4. Kiat, Samir S, Rofail-Seng Yeo, Wang-Ling Goh, CMOS/BiCMOS ULSI Low Voltage Low Power, Pearson, 2002.
5. Ajith Pal, Low-Power VLSI Circuits and Systems, Springer, 2015.

ECE 5261 RESEARCH LAB [0 0 6 2]

Student is assigned under a Faculty for specific research area like VLSI, Signal Processing, Wireless communication, Real time embedded systems, Biomedical engineering. Students are evaluated based on synopsis presentation, mid-term and final evaluation along with report. The evaluation is conducted by the assigned Faculty in consultation with program coordinator and lab coordinator.

SEMESTER III & IV

ECE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

ECE 5001 ADVANCED DIGITAL SIGNAL PROCESSING [4 0 0 4]

Signals, Multi-rate Systems, Interpolated FIR Filters for Decimation and Interpolation Filters, Quadrature Mirror Filter Bank (QMF), Half band and multiband filters, PR systems. Principle of Adaptive filters, Tapped Delay Line and Weiner Filters, Steepest Descent Algorithm, LMS Algorithm. Homomorphic system, Complex Cepstrum, Hilbert transform, Homomorphic systems, applications. Discrete-time random processes, Signal modeling, Spectrum estimation.

References:

1. J. G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms, & Applications, 4/e, Pearson Education, 2007.
2. P. P Vaidyanathan, Multirate Systems And Filter Banks, Prentice Hall, India,1993.

3. A.V Oppenheim.and R.W. Schafer, Digital Signal Processing, Prentice Hall, 1992.
4. S. J Orfanidis, Optimum Signal Processing, Mc Graw Hill , NJ ,2007.
5. M H Hayes, Statistical signal processing and modeling, John Wiley &Sons, Inc, 2002,

ECE 5002 ADVANCES IN CIRCUIT ELEMENTS [4 0 0 4]

Fundamental circuit elements, Gyrator, Emulation of grounded and floating inductor, Emulation of negative circuit elements, New circuit elements: Frequency Dependent Negative Resistor, Constant Phase Element , Fractional Order Elements - Fractional Order Capacitor, Fractional Order Inductor, Memristor: modeling. Emulation and applications

References:

1. Georgia Tsirimokou, Costas Psychalinos, Ahmed Elwakil, Design of CMOS Analog Integrated Fractional-Order Circuits: Applications in Medicine and Biology, Springer, May 2017.
2. Aleksei Tepljakov, Fractional-order Modeling and Control of Dynamic Systems, Springer Thesis, 2017.
3. Vourkas, Ioannis, Sirakoulis, Georgios, Memristor Based Nanoelectronic Computing Circuits and Architectures, Springer Publishers, 2016.
4. Vaidyanathan, Sundarapandian, Volos, Christos, Advances in Memristors, Memristive Devices and Systems, Springer Publishers, 2017.
5. Biswas, K., Bohannan, G., Caponetto, R., Mendes Lopes, A., Tenreiro Machado, J.A., Fractional-Order Devices, Springer Publishers, 2017.

ECE 5003 ANALOG VLSI FOR SIGNAL PROCESSING [4 0 0 4]

Basic CMOS Circuit Techniques, Continuous- Time Signal Processing. Low Voltage Signal Processing. Current- Mode Signal Processing: Continuous- Time Signal Processing, Sampled-Data Signal Processing, Switched-Current Data Converters. Analog Filters. Statistical Modeling and Simulation, Correlations and Principal Component Analysis, Statistical device Modeling, Statistical Circuit Simulation, Analog Layout.

References:

1. Mohammed Ismail, Analog VLSI : Signal and Information Processing, McGraw-Hill, 1994.
2. R.Schaumann, M.S.Ghausi, Kenneth R Laker, Design of Analog Filters Passive, Active RC, and Switched Capacitor, Prentice Hall, 1995.
3. T Deliyanis, Y.Sun and J.K.Fidler, Continuous-Time Active Filter Design, CRC Press,1999.
4. P.V.Anand Mohan, Current-mode VLSI Analog Filters: Design and Applications, Birkhauser, 2003.

ECE 5004 CAD TOOLS FOR VLSI [4 0 0 4]

Graph Theory, Graph optimization Problems and Algorithms. Programmable logic devices, FPGA Classification. Architectural Synthesis, Scheduling, Different types of scheduling with and without resource constraint algorithms. Two level combinational logic synthesis and optimization; Exact and heuristic method. Fault Simulation - Automatic test pattern generation (ATPG) techniques, Design for Testability.

References:

1. Giovanni De Michelli : Synthesis and Optimisation of Digital Circuits, Tata-McGraw Hill, New Delhi,2008.
2. Gary D. Hachtel, Fabio Somenzi, Logic Synthesis and Verification Algorithm, Kluwer Academic Publication, Boston,2002.
3. M.J.S.Smith, Application Specific ICs, Addison Wesley, 2002.I Analog Filters: Design and Applications, Birkhauser, 2003.

ECE 5005 CODING THEORY [4 0 0 4]

Information – entropy, information rate, classification of codes, text, audio and speech coding. source coding: image and video. Error control coding: block codes, cyclic codes; syndrome calculation, encoder and decoder, CRC, convolutional codes; sequential search and Viterbi algorithm; turbo coding.

References:

1. R Bose, Information Theory, Coding and Cryptography, TMH 2007
2. Fred Halsall, Multimedia Communications: Applications, Networks, Protocols and Standards, Pearson Education Asia, 2002
3. S Gravano, Introduction to Error Control Codes, Oxford University Press 2007
4. Mark Nelson, Data Compression Book, BPB Publication 1992.
5. Watkinson J, Compression in Video and Audio, Focal Press, London, 1995. ers: Design and Applications, Birkhauser, 2003.

ECE 5006 CRYPTOGRAPHY & NETWORK SECURITY [4 0 0 4]

Classical Encryption Techniques. Public-Key Cryptography and RSA. Key Management and Distribution: Wireless Network Security: Security Technology Firewalls and VPNs; Access control. Firewalls. Virtual Private Networks. Intrusion Detection and Prevention Systems. Honeypots, Honey-nets and Padded cell systems. Scanning and analysis tools. Biometric access controls.

References:

1. William Stallings, Cryptography and Network Security, Pearson 6th edition. 2004
2. M. E. Whitman and Herbert J. Mattored, Principles of Information Security, Information Security Professional, Fourth edition, 2011.
3. K. Pachghare, Cryptography and Information Security. PHI Learning, 2015

ECE 5007 DATA COMPRESSION [4 0 0 4]

Compression techniques, modeling and coding. Information theory and coding; Prediction with partial match, the Burrows-Wheeler transform, CALIC, JPEG-LS, multi resolution approaches, Facsimile encoding. Distortion criteria, models, The quantization problem, Vector spaces, image compression and audio compression techniques. Filters, sub band coding algorithms, bit allocation, Application to speech coding, audio coding, and image compression, wavelets.

References:

1. Khalid Sayood, Introduction to Data Compression, Addison Wesley. 2000.
2. David Salomon, Data Compression, 2nd Edn., Springer,2000.
3. Toby Berger, Rate Distortion Theory: A Mathematical Basis for Data Compression, Prentice Hall, 1971.
4. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory, John Wiley & Sons, Inc,1991.
5. Ali N. Akansu, Richard A. Haddad, Multi resolution signal decomposition: Transforms, Subbands and Wavelets, Academic Press, 1992.

ECE 5008 DETECTION & ESTIMATION THEORY [4 0 0 4]

Classical detection and estimation theory and techniques, Qualities of good estimators, Cramer-Rao bound. Signal representation; Karhunen-Loeve series expansion method. Detection of signals and signal parameter estimation. Applications to binary digital communication systems. Signal detection in discrete time. Estimation of signal parameters; Detection of signals in colored noise. Filtering techniques, Wiener-Hopf equations.

References:

1. Vincent Poor H, An Introduction to Signal Detection and Estimation, Springer, Second Edition, 1994
2. Van Trees H L, Detection Estimation and Modulation Theory – Part I, John Wiley, New York, 2002.
3. Mourad Barkat, Signal Detection and Estimation, Artech House, Second Edition, 2005

ECE 5009 DIGITAL IMAGE PROCESSING [4 0 0 4]

Image Acquisition System, Image Sampling and Quantization; Color Models, Pseudo and Full-Color Image processing; Point Processing, Spatial operations, Smoothing and sharpening spatial filters. 2D DFT; Transform Operations, Smoothing and sharpening using frequency domain filters, Homomorphic Filtering. Image Degradation / Restoration Process, Detection of Discontinuities, Image Compression and standards, Wavelets and its applications in Image Processing.

References:

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson, 2008.
2. Anil K Jain, Fundamentals of Digital Image Processing, Pearson, 2001
3. W. K. Pratt, Digital Image Processing, Wiley 2010

ECE 5010 DIGITAL SPEECH PROCESSING [4 0 0 4]

Anatomy and Physiology of speech production, Acoustic theory of speech production, Uniform lossless tube model, Effects of losses in the vocal tract, Digital models for speech signals. Time-dependent processing of speech; Short time Auto-correlation, Pitch period estimation. Short Time Fourier Transform Analysis, Speech redundancies, Speech Synthesis, Feature Extraction; Artificial Neural Networks for speech recognition.

References:

1. Rabiner L.R, Schaffer R.W, Digital Processing of Speech Signals, Prentice Hall, NJ, 2007.
2. Thomas F. Quatieri, Discrete-time Speech Signal Processing-Principles and Practice, Pearson Education Inc, 2004.
3. Douglas O' Shaughnessy, Speech Communications: Human and Machine Reading, Addison-Wesley. 2nd edition, 1999.
4. Deller J.R, Proakis G.J and Hansen J.H.L, Discrete Time Processing of Speech Signals, IEEE Press. 2000.
5. Rabiner L.R and Jaung, Fundamentals of Speech Recognition, Prentice Hall. 1993.

ECE 5011 EMBEDDED SYSTEM DESIGN [4 0 0 4]

Characteristics, Classification, Model of embedded system. Embedded hardware; Embedded Firmware design and development. Hardware-Software Co-Design. Computational models, Unified modelling language, Hardware software trade-offs. Operating systems, Inter process communication, Task synchronization, Semaphores, Priority inversion, Device drivers, Scheduling algorithms. Packaging, Enclosure design and development. Embedded Product Development Life Cycle.

References:

1. Shibu K.V. Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Lyla.B.Das,Embedded Systems, An Integrated Approach, Pearson Ed, 2013
3. Abraham Silberschatz,Peter Baer Galvin and Greg Gagne, Operating System Concepts, 7th Edition Wiley Higher Education, 2005
4. Hermann Kopetz, Real-time systems: design principles for distributed embedded applications, Kluwer Academic publishers, 2002

ECE 5012 HIGH SPEED DIGITAL DESIGN [4 0 0 4]

High speed logic gates; Measurement Techniques. Transmission Lines: Shortcomings of ordinary point-to-point wiring, effects of source and load impedance, Ground Planes and Layer Stacking; Terminations and Vias; Power Systems: distribution problems. Connectors, Special Connectors, Ribbon Cable. Clock Distribution, Using canned clock oscillators, Clock jitter

References:

1. Howard Johnson, Martin Graham, High-Speed Digital Design, A handbook of black magic, Pearson Education, 2008.
2. Stephen H. Hall & Howard L. Heck, Advanced Signal Integrity for High-Speed Digital Designs, John Wiley & Sons, 2009
3. William J Dally & John W Poulton, Digital Systems Engineering, Cambridge University Press, 1998
4. Eric Bogatin, Signal and Power Integrity- Simplified, 2ndEdition, Prentice Hall, 2010

ECE 5013 LARGE AREA MICRO ELECTRONICS [4 0 0 4]

Non-crystalline semi-conductor basics, Difference between, amorphous, polycrystalline and micro /nano crystalline hydrogenated silicon (a-Si:H), Thin Film transistor, LEDs, Large Area Image Sensor Arrays, Thin Film Position Sensitive Detectors. Field emission displays. Introduction to organic semiconductors- structure and geometry, stretchable and conformal electronics.

References:

1. Richard Zallen, The Physics of Amorphous solids, Wiley, 2007.
2. Sanjiv Sambandan, CIRCUIT DESIGN- Techniques for Non-Crystalline Semiconductors, CRC press, 2013.
3. Robert A. Street, Technology and Applications of Amorphous Silicon,. Springer-Verlag New York, LLC Series: Series in Materials Science, 2004.
4. A.Madan & M.P.Shaw , The Physics and Technology of Amorphous silicon, Elsevier Science & Technology books, 2012.
5. Takao Someya, Stretchable Electronics, Wiley-VCH; 1 Edition, January 29, 2013.

ECE 5014 MEMS TECHNOLOGY [4 0 0 4]

Background of MEMS, Bulk micromachining, surface micromachining, Micro-cantilevers, design of MEMS sensors, RF MEMS devises, Biosensors, MEMS device packaging

References:

1. Stephen D.Senturia Microsystem design, Kluwer Academic publications, 2001
2. Marc Madou, Fundamentals of Microfabrication, CRC Press, 1997
3. H. Bao, Micromechnanical Transducers: pressure sensors, accelerometers, and gyroscopes, Elsevier, NewYork 2000

4. Gabriel M Rebeiz, RF MEMS Theory, design and technology. Wiley Inter science,2003
5. Sergey Y.Yurish, Mearia Teresa S.R.Gomes, Smart sensors and MEMS, Kluwer Academic Publishers, 2003

ECE 5015 MICROWAVE AND MILLIMETER WAVE ANTENNA [4 0 0 4]

Millimeter Wave Technology, Microwave and Millimeter Wave Systems, Guiding Structures, Metamaterials. Millimeter Wave Antennas: Path Loss and Antenna Directivity, Antenna Beam width, Maximum Possible Gain to Q, Polarization, Beam Steering Antenna, Millimeter Wave Design Consideration, Millimeter Wave Propagation, Fifth-generation systems

References:

1. Duixian Liu, Ulrich Pfeiffer, Janusz Grzyb and Brian Gaucher, Advanced Millimetre-wave Technologies: Antennas, Packaging and Circuits , Wiley, 2009
2. Sergey M. Smolskiy, Leonid A. Belov and Victor N. Kochemasov, Handbook of RF, Microwave, and Millimetre-Wave Components, Artech House Microwave Library, 2013
3. Kao-Cheng Huang, Zhaocheng Wang, Millimetre Wave Communication Systems, Wiley, 2011
4. Shiban K. Koul, Millimetre Wave and Optical Dielectric Integrated Guides and Circuits, Wiley-Inter science, 1st edition, 200.
5. David M. Pozar, Microwave and RF Design of Wireless Systems, Wiley, 2000.

ECE 5016 NANO PHOTONICS [4 0 0 4]

Light generation by nanostructures, semiconductor quantum wells, nanocrystals, nanowires.

Light propagation in nanostructures, Photonic crystals, dielectric periodic structures. Surface Plasmon, transmission through subwavelength hole, subwavelength waveguides. Near-field optics, Nano-photonics.

References:

1. Lukas Novotny and Bert Hecht Principles of Nano-Optics, Cambridge University Press, 2012.
2. Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande and Juan Ariel Levenson, Nanophotonics, Wiley, 2006.
3. Mark L. Brongersma and Pieter G. Kik, Surface Plasmon Nanophotonics, Springer, 2006.
4. P.N. Prasad, Nanophotonics, Wiley-Interscience, 2003
5. John D. Joannopoulos, Robert D. Meade and Joshua N. Winn, Photonic Crystals, MIT Press, 2007

ECE 5017 NONLINEAR FIBER OPTICS [4 0 0 4]

Nonlinear optical effects in crystals. Pulse propagation through optical fibers. Third order dispersion, dispersion management. SPM induced spectral broadening, higher order nonlinear effects, optical solitons, XPM. Stimulated Raman and Brillouin scattering. Parametric processes

References:

1. G. P. Agarwal, Nonlinear Fiber Optics, Academic Press, 2007.
2. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, 2007
3. G. P. Agarwal, Applications of Nonlinear Fiber Optics, Academic Press 2008.
4. R. W. Boyd, Nonlinear Optics, Academic Press 2008

ECE 5018 QUANTUM INFORMATION SCIENCE [4 0 0 4]

Classical Computation, Turing Machines and Circuits, Information, Erasure, Reversibility.

Single Quantum Bits. Multiple Quantum Bits, Entanglement. Measurements, EPR-Bell Theorem. Quantum Transformations: Reversible Gates, Quantum Circuit Model. Quantum Algorithms: Deutch-Jozsa's and Simon's Problems, Subsystems. Error Corrections.

References:

1. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2014 (Paperback edition).
2. Giuliano Benenti, Giulio Casati, and Giuliano Strini, Principles of Quantum Computation and Information, Volumes I and II, World Scientific, 2004.
3. Kaye, Laflamme, and Mosca, An Introduction to Quantum Computing, Oxford University Press, 2007.
4. Nielsen and Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2011.

ECE 5019 RADAR SYSTEMS [4 0 0 4]

Radar theory, range equation, transmitters, antennas. Tracking radar, detection and extraction, SNR. Duplexers, Doppler effect, High resolution radars. Electronic counter measure, Case studies.

References:

1. M.I.Skolnik, Introduction to Radar Systems3rd Ed., McGraw Hill, 2003.
2. Peyton Z. Peebles Jr., Radar Principles. John Wiley, 2004.
3. Edde Byron, Radar: Principles, Technology, Applications, Prentice-Hall education ,2004.
4. David Barton, Radar system analyses and Modeling, Artech house, 2005

ECE 5020 RF MICROELECTRONICS CHIP DESIGN [4 0 0 4]

RF circuit design, Basic RF modules, Passive and active RF components, RF power amplifier, impedance matching, low noise amplifier (LNA), RF Filters, oscillators, mixers, modulators, detectors, and synthesizers.

References:

1. Thomas H. Lee Design of CMOS Radio-Frequency Integrated Circuits Cambridge University press, 2003.
2. Behzad Razavi RF Microelectronics, Prentice Hall International Publisher, 1998.
3. W. Alan Davis, Krishna K. Agarwal, Radio Frequency Circuit Design, John Wiley & Sons Inc., 2001.
4. Cotter W. Sayre, Complete Wireless Design, McGraw-Hill Professional Publisher, 2008.
5. John M. W. Rogers, John W. M. Rogers, Calvin Plett , Radio Frequency Integrated Circuit Design , Artech House Publishers, 2010.

ECE 5021 SEMICONDUCTOR DEVICE PHYSICS [4 0 0 4]

Review of Quantum mechanics, crystalline solids and energy bands, Fundamentals of semiconductor physics, Device Physics – Diode, Schottky diode, Tunnel diode, Transistors; MOS Structures, Semiconductor measurements.

References:

1. S. Selberherr, Analysis and Simulation of Semiconductor Devices, Springer-Verlag, 1984.
2. J. P. McKelvey, Introduction to Solid State and Semiconductor Physics, Harper and Row and John Weathe Hill, 1966.
3. D.K. Schroder, Semiconductor Material and Device Characterization, John Wiley, 1990.
4. S. M. Sze, Physics of Semiconductor Devices, 2nd edition John Wiley, 1981.
5. M A Achuthan & K N Bhat, Fundamentals of Semiconductor Devices Tata Mc Graw Hill.

ECE 5022 SPREAD SPECTRUM COMMUNICATION [4 0 0 4]

Direct sequence and frequency hop spread spectrum systems. Hybrid direct sequence/frequency hop spread spectrum. Sequence generators. Spread spectrum communication system model, diversity reception in fading channels, cellular radio concept, single and multicarrier CDMA.

References:

1. R. L. Peterson, R. E. Zeimer and D. E. Borth, Introduction to Spread Spectrum Communications, Pearson, 1995.
2. J. D. Proakis and M. Salehi, Digital Communication, McGraw Hill, 2008.
3. A. J. Viterbi, CDMA: Principles of Spread Spectrum Communications, Addision Wesley, 1995.
4. S. Verdu, Multiuser Detection, Cambridge University Press, 1998

ECE 5023 SYSTEM ON CHIP DESIGN [4 0 0 4]

SoC architecture, design issues; SoC design flow; logic cores, memory and analog cores; Design validation, Testing, embedded memories, analog and mixed signal core. Low power architecture, Subsystem design principles, Floor planning, Off- chip connections, RTL design, High level synthesis, System on –chips Embedded CPUs, Hardware/ Software Co –Design.

References:

1. Rochit Rajsuman, System on a Chip Design and test, Artech House, Bosten , London, ed., 2000
2. Peter J. Ashenden, Jean P. Mermet, Ralf Seepold, System on chip methodologies & design languages, Boston: Kluwer Academic Publishers, 2001
3. Wayne Wolf, Modern VLSI Design: System on Chip Design, Pearson, 2005
4. Michael Keating, Pierre Bricaud, Reuse methodology manual for system-on-a-chip designs, Boston: Kluwer Academic Publishers, 2001
5. Steve Furber, ARM System on Chip Architecture, 2nd Edition, Additon Wesley professional, 2001.

ECE 5024 TIME-FREQUENCY AND WAVELET TRANSFORMS [4 0 0 4]

Time-frequency analysis and wavelet transforms. STFT. Two-channel filter bank and analysis, Quadrature mirror and conjugate quadrature filters, Haar transforms. Daubechies four-coefficient wavelet. Sampling. CWT, DWT, filter banks: Signal decomposition. parametric wavelets, Orthogonality conditions and parameterization, poly phase matrix and recurrence relation. Biorthogonal wavelets, Applications.

References:

1. P. S Addison, The illustrated Wavelet transform Handbook, Institute of Physics Publishing, 2002.
2. C S Burrus, A Gopinath, and Haitao Guo, Introduction to wavelets and wavelet transforms, Prentice-Hall, 1998.
3. K P Soman and K. I. Ramachandran, Insight into Wavelets from theory to practice, Prentice-Hall of India, 2005. .

ECE 5025 VLSI PHYSICAL DESIGN AND VERIFICATION [4 0 0 4]

ASICs, design flow, Transistor resistance and capacitance, timing analysis; Synopsys Prime time tool for STA, Clock tree Synthesis, Power grid analysis. Physical design, Algorithms for design automation, Clustering, System partitioning. Chip planning, Floor Planning, Placement & Routing, Algorithms, Transmission line effects and Interconnect modeling. Verification, Verilog scheduling and execution semantics. Combinational equivalence checking, modeling sequential systems, model checking, Simulator architectures.

References:

1. Weste N. and Harris D, CMOS VLSI Design: A Circuits and Systems Perspective, 4th ed. Pearson, 2010.
2. S. Sait, H. Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific, 1999
3. William K. Lam, Hardware Design Verification: Simulation and Formal Method-Based Approaches, Prentice hall PTR, 2005
4. Pallab Dasgupta, A Roadmap for Formal Property Verification, Springer, Neetherland, 2006
5. Smith M.J.S, Application Specific Integrated Circuits, Addison Wesley, 1997

ECE 5026 VLSI TESTING & TESTABILITY [4 0 0 4]

Digital and analog testing, Controllability and observability, Design-for-test, Test process and ATE, Fault modeling. Testing of combinational and sequential circuits. Test optimization and fault coverage. Testability - adhoc and structured approaches, Boundary scan. Signatures and Built-in self test, Reed-Muller and spectral coefficients, Signature analysis and Online self test.

References:

1. M. L. Bushnell and V. D. Agrawal, Essentials of testing for digital, memory and mixed-signal VLSI circuits, Boston: Kluwer Academic Publishers, 2013.
2. Miczo, Digital Logic Testing and simulation. New York: Harper & Row, 2003.
3. P.K. Lala, Fault Tolerant & Fault Testable hardware Design, BS Publications, 2013
4. Stanley L. Hurst, VLSI Testing: digital and mixed analogue digital techniques Inspec/IEEE, 1999.
5. M. Abramovici, M. A. Breuer, and A.D. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1994

OPEN ELECTIVES

ECE 5051 ARM PROCESSOR AND APPLICATIONS [3 0 0 3]

ARM Embedded systems, Processor Fundamentals, Instruction Set, Thumb Instruction Set. Cortex-M0 architecture- Memory System, MMU, Interrupts and Exceptions. Cortex-M0 OS support features; Cortex-M0 fault handling; Application programming.

References:

1. Andrew Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Elsevier, Morgan Kaufmann publisher, 2004.
2. Steve Furber, ARM System-on-Chip Architecture, 2nd Edition, Additon-Wesley professional, 2001.
3. Joseph Yiu, The Definitive Guide to the ARM Cortex-M0, Elsevier, Newnes, 2011.
4. Dr Alexander G. Dean, Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach, ARM Education Media, 2017..

ECE 5053 NEURAL NETWORKS & FUZZY LOGIC [3 0 0 3]

Biological neurons, Mc-culloch Pitt's model, Feed forward and Feedback network, Supervised and unsupervised learning. learning rules. Classifiers; Discrete time and gradient type, Hopfield networks, Unsupervised learning methods; cluster discovery network, Counter propagation networks. kernel methods. Fuzzy Logic: fuzzy systems, membership functions, classical sets and fuzzy sets, fuzzy set rules. Fuzzy relations, Approximate reasoning. Fuzzy inference engine, Fuzzifiers, Defuzzifiers, Neuro fuzzy systems, with GA optimization

References:

1. Jacek M Zurada, Introduction to artificial Neural Systems, Jaico publication. 2006
2. Simon Haykin, Neural Networks and Learning Machines, PHI edition private Limited,3rd edition, New Delhi, 2009
3. Li Xin Wang, Introduction to fuzzy systems and control, Prentice Hall publication, 1997
4. Timothy J Ross, Fuzzy Logic with Engineering Applications, Intl. Edition, McGraw Hill publication, 2008

ECE 5052 NANO ELECTRONICS [3 0 0 3]

Nanomaterials, Nanostructured materials, Capabilities, physical fundamentals. Scaling principles, limits to scaling, power constrained scaling limits. Electronic transport in 1,2 and 3 dimensions- Quantum confinement. Electronic and optoelectronic properties of molecular materials. Spin tunneling devices, Ferroelectric random access memory, semiconductor sensor array. Nanotechnology for biological system & bio-sensor applications.

References:

1. V. Mitin, V. Kochelap, M. Stroscio, Introduction to Nano-electronics, Cambridge University Press, 2008.
2. Rainer Waser,Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH,2003.
3. Karl Goser, Peter Glosekotter, Jan Dienstuhl, Nano-electronics and Nano-systems, Springer, 2004.
4. Sadamichi Maekawa, Concepts in Spin Electronics, Oxford University Press, 2006.
5. Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience , Wiley-VCH, 2006

ECE 5027 PRINTED ELECTRONICS [4 0 0 4]

Introduction to Printed Electronics and their Materials Systems, Emerging technologies, General applications, Carrier transport, doping, band structure, thin-film electronic devices.

Printed Electronics: Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, paper-based electronics, textile substrates, barrier materials. Thin-film Deposition techniques. Device structure and performance: I-V characteristics, Mechanics of Thin films and Flexible Transistors: thin-film mechanics models, neutral plane, conformal electronics, mechanical modelling.

Solution-based Patterning Processes: Ink-jet printing, gravure, Roll-to-Roll printing, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning Contacts and Interfaces to Organic andInorganic Electronic Devices: Schottky contacts, defects, carrier recombination, effect ofApplied mechanical strain.

Displays, sensor arrays, memory devices, lab-on-chip, and photovoltaics.

References:

1. Wong, William S., Salleo, Alberto (Editors), Flexible Electronics: Materials and Application, Springer, U.S./India , 2009.
2. Guozhen Shen, Zhiyong Fan (Editor) - Flexible Electronics: From Materials to Devices World Scientific, U.S. 2016
3. Takao Someya (Editor) – Stretchable Electronics – Wiley International, U.S. – 2013

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING, MIT Manipal

M.Tech. DIGITAL ELECTRONICS & COMMUNICATION ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5151	Probability, Random Variables and Stochastic Processes	4	0	0	4	ECE 5251	Optical Communication	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ECE 5253	Wireless Communication	4	0	0	4
	ECE 5151	Communication Networks and Protocols	4	0	0	4	ECE ****	Elective I	4	0	0	4
	ECE 5152	Digital VLSI Design	4	0	0	4	ECE ****	Elective II	4	0	0	4
	ECE 5153	Modern Digital Communication	4	0	0	4	ECE ****	Elective III	4	0	0	4
	ECE 5154	Processor Architecture and Applications	4	0	0	4	*** ****	Open Elective	3	0	0	3
	ECE 5161	Digital Electronics and Communication Lab	0	0	6	2	ECE 5261	Research Lab	0	0	6	2
	ECE 5162	Networks Lab	0	0	3	1						
		Total	**21**	**0**	**12**	**25**		**Total**	**23**	**0**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	ECE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES					
ECE 5001	Advanced Digital Signal Processing	ECE 5010	Digital Speech Processing	ECE 5019	Radar Systems
ECE 5002	Advances in Circuit Elements	ECE 5011	Embedded System Design	ECE 5020	RF Microelectronics Chip Design
ECE 5003	Analog VLSI for Signal Processing	ECE 5012	High Speed Digital Design	ECE 5021	Semiconductor Device Physics
ECE 5004	Cad Tools for VLSI	ECE 5013	Large Area Micro Electronics	ECE 5022	Spread Spectrum Communication
ECE 5005	Coding Theory	ECE 5014	Mems Technology	ECE 5023	System on Chip Design
ECE 5006	Cryptography and Network Security	ECE 5015	Microwave and Millimeter Wave Antenna	ECE 5024	Time-Frequency and Wavelet Transforms
ECE 5007	Data Compression	ECE 5016	Nanophotonics	ECE 5025	VLSI Physical Design and Verification
ECE 5008	Detection and Estimation Theory	ECE 5017	Nonlinear Fiber Optics	ECE 5026	VLSI Testing and Testability
ECE 5009	Digital Image Processing	ECE 5018	Quantum Information Science	ECE 5027	Printed Electronics

OPEN ELECTIVES			
ECE 5051	ARM Processor and Applications	ECE 5053	Neural Networks and Fuzzy Logic
ECE 5052	Nano Electronics		

SEMESTER I

MAT 5151 PROBABILITY, RANDOM VARIABLES AND STOCHASTIC PROCESSES [4 0 0 4]

Statistical Inference: Random Sampling, Sampling distributions, Parameter Estimation and Hypothesis Testing, Regression, Correlation and Analysis of Variance - Examples.
Static probabilities, Dynamic probability. Classification of states, chains of Markov process. Stability of Markov systems, limiting behavior, random walk.
Poisson Processes: assumptions and derivations, related distributions, birth and death processes. Queuing System, general concepts, Model M/M/1 and M/M/S, steady state behavior, transient behavior.

References:

1. Hogg & Craig (1975), "Introduction to Mathematical Statistics", 4th Edn., MacMillan,
2. J.Medhi, "Stochastic Processes".
3. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
4. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology, A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo& David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology, (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain& Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

ECE 5151 COMMUNICATION NETWORKS AND PROTOCOLS[4 0 0 4]

Network Services and Layered Architecture. Packet Switched Network. Asynchronous Transfer Mode: Classical IP over ATM. Wireless Networks: Wireless Channel: Path loss, fading, Inter symbol Interference, Doppler frequency shift, Capacity limits. Optical Networks. single hop and Multi hop LAN, SONET/SDH

References:

1. JeanWalrand, Pravin Varia, High Performance Communication Networks, 2nd edition, 2009.
2. Behrouz. A, Forouzan, Data Communication and Networking, Tata McGrawHill,2008
3. Albert Leon-Garcia, IndraWidjaja, Communication Networks: Fundamental Concepts and Key Architectures, Tata McGraw –Hill 2nd Edition, 2004
4. Sumit Kasera and Pankaj Sethi, ATM Networks Concept and Protocol, Tata McGraw Hill Publication, 2006.
5. Rajiv Ramaswami, Kumar N. Optical Networks, Morgan Kaufmann Publishers 2nd Edition, 2008.

ECE 5152 DIGITAL VLSI DESIGN [4 0 0 4]

MOS Transistor theory, Inverters, Digital circuit design, VLSI Fabrication and Layouts, CMOS/Bulk technology, SOI technology. Basic circuit concepts and performance estimation: Design Margins and Reliability; Pseudo-NMOS circuits, Dynamic CMOS logic, Domino CMOS structure and design, CCMOS, BiCMOS; Subsystems and Building Blocks; Semiconductor memories. Interconnects in VLSI

References:

1. Neil Weste and K. Eshragian, Principles of CMOS VLSI Design: A System Perspective, Pearson Education, 2000.
2. Jan M, Rabaey, et al, Digital Integrated Circuits: A Design Perspective, Prentice Hall, 2003.
3. Wayne, Wolf, Modern VLSI design: System on Silicon Pearson Education, 2005.
4. Sung, Mo Kang and YosufLeblebici, CMOS Digital Integrated Circuits: Analysis and Design, TMH, 2003
5. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design PHI, 2005.

ECE 5153 MODERN DIGITAL COMMUNICATION [4 0 0 4]

Characterization of Signals and Systems, Memory and Memoryless Modulation, Optimum Receivers for AWGN channels. Performance of Digital Modulation Techniques, Channel Estimation and Equalization. Synchronization techniques.Convolutional codes, Viterbi algorithm, sequential decoding algorithms, performance with soft and hard decoding,TCM and Turbo coding techniques. Modulation and Diversity reception techniques to counter fading, space- time coding techniques.

References:

1. Proakis. J. G.: MasoudSalehi, Digital communications, McGraw Hill publication,2007
2. Sklar B,:Digital Communication: Fundamentals & Applications, Pearson Education,2001.
3. Rodger E Zeimer , Wiiliam H Tranter, Principles of Communication: system, modulation, noise, Wiley Publication, 2007
4. Simon Haykin, Digital Communication, Wiley student edition, 2006
5. M.Sathish Kumar, Digital Communication, PHI Learning, 2019

ECE 5154 PROCESSOR ARCHITECTURE AND APPLICATIONS [4 0 0 4]

Processor Data Path and Control, Pipelining, pipeline hazards, Memory hierarchy, Memory and I/O interface, multiprocessors, parallel processors, performance, Digital Signal Processors, architecture and applications

References:

1. David A.Patterson& John L.Hennessy, Computer Organization and Design-The Hardware/Software Interface, Third Edition, Elsevier, 2005
2. John L.Hennessy and David A.Patterson, Computer Architecture-A Quantitative Approach, Fourth Edition, Elsevier, 2007
3. Phil Lapsley,DSP Processor Fundamentals, IEEE Press, 1997
4. Sen M. Kuo, Woon-Seng Gan Digital Signal Processors, Pearson, 2005
5. Andrew N.Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Elsevier, 2004

ECE 5161 DIGITAL ELECTRONICS AND COMMUNICATION LAB [0 0 6 2]

Communication experiments using Matlab, HFSS, and OptSimand LabVIEW. Experiments using universal software radio peripheral (USRP) transceivers for prototyping wireless communication systems.

ECE 5162 NETWORKS LAB [0 0 3 1]

Experiments are conducted using Simulators like QualNet, NS2 and NS3. To simulate the Network Protocols, Mobile Ad hoc Network Protocols, Wireless Sensor Networks Protocols.

SEMESTER II

ECE 5253 WIRELESS COMMUNICATION [4 0 0 4]

Modeling of wireless channels, Wide-sense stationary uncorrelated scattering assumption; characterizing key parameters of wireless channels, wireless channel discretization and discrete-time representation. Non-coherent and coherent reception. Time and Frequency diversity. Rake receiver. Channel capacity; Data transmission using multiple carriers and challenges. OFDM, challenges in multicarrier modulation, MIMO systems and space time coding, smart antennas.

References:

1. Goldsmith, Andrea. Wireless communications. Cambridge university press, 2005.
2. D. Tse and P. Vishwanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
3. T. S. Rappaport, Wireless Communication: Principles and Practice, Pearson, 2002
4. J. G. Proakis and M. Salehi, Digital Communications, McGraw-Hill, 2008
5. K. Fazel and S. Kaiser, Multicarrier and Spread Spectrum Systems, Wiley, 2003

ECE 5251 OPTICAL COMMUNICATION [4 0 0 4]

Planar dielectric waveguides: Step and graded index fibers. Hi-Bi fibers. Distortion of optical pulses propagating through fibers. Fiber amplifiers; EDFA, SOA. Advanced modulation and demodulation formats for optical fiber communications: coherent detection of ASK, FSK and PSK. Optical DQPSK, DOPSK and QAM. Multiplexing techniques. Multiplexing techniques. Wave propagation through anisotropic media. Non-linear fiber optics

References:

1. G. Keiser, Optical Fiber Communications, Tata McGraw Hill, New Delhi, 2010.
2. M. Sathish Kumar, Fundamentals of Optical Fiber Communication, Prentice Hall of India, New Delhi, 2nd ed., 2014
3. A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press, NY, 1989
4. G. P, Agrawal, Nonlinear Fiber Optics, Elsevier, 4th ed., 2010

ECE 5261 RESEARCH LAB [0 0 6 2]

Student is assigned under a Faculty for specific research area like VLSI, Signal Processing, Wireless communication, Real time embedded systems, Biomedical engineering. Students are evaluated based on synopsis presentation, mid-term and final evaluation along with report. The evaluation is conducted by the assigned Faculty in consultation with program coordinator and lab coordinator.

ECE 5001 ADVANCED DIGITAL SIGNAL PROCESSING [4 0 0 4]

Signals, Multi-rate Systems, Interpolated FIR Filters for Decimation and Interpolation Filters, Quadrature Mirror Filter Bank (QMF), Half band and multiband filters, PR systems. Principle of Adaptive filters, Tapped Delay Line and Weiner Filters, Steepest Descent Algorithm, LMS Algorithm. Homomorphic system, Complex Cepstrum, Hilbert transform, Homomorphic systems, applications. Discrete-time random processes, Signal modeling, Spectrum estimation.

References:

1. J. G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4/e, Pearson Education, 2007.
2. P. P Vaidyanathan, Multirate Systems And Filter Banks, Prentice Hall, India,1993.
3. A.V Oppenheim.and R.W.Schafer, Digital Signal Processing, Prentice Hall, 1992.
4. S. J Orfanidis, Optimum Signal Processing, Mc GrawHill , NJ ,2007.
5. M H Hayes, Statistical signal processing and modeling, John Wiley &Sons, Inc, 2002,

ECE 5002 ADVANCES IN CIRCUIT ELEMENTS [4 0 0 4]

Fundamental circuit elements, Gyrator, Emulation of grounded and floating inductor, Emulation of negative circuit elements, New circuit elements: Frequency Dependent Negative Resistor, Constant Phase Element, Fractional Order Elements - Fractional Order Capacitor, Fractional Order Inductor, Memristor: modeling. Emulation and applications

References:

1. Georgia Tsirimokou, Costas Psychalinos, Ahmed Elwakil, Design of CMOS Analog Integrated Fractional-Order Circuits: Applications in Medicine and Biology, Springer, May 2017.
2. AlekseiTepljakov, Fractional-order Modeling and Control of Dynamic Systems, Springer Thesis, 2017.
3. Vourkas, Ioannis, Sirakoulis, Georgios, Memristor Based Nanoelectronic Computing Circuits and Architectures, Springer Publishers, 2016.
4. Vaidyanathan, Sundarapandian, Volos, Christos, Advances in Memristors, Memristive Devices and Systems, Springer Publishers, 2017.
5. Biswas, K., Bohannan, G., Caponetto, R., Mendes Lopes, A., Tenreiro Machado, J.A., Fractional-Order Devices, Springer Publishers, 2017.

PROGRAM ELECTIVES

ECE 5003 ANALOG VLSI FOR SIGNAL PROCESSING [4 0 0 4]

Basic CMOS Circuit Techniques, Continuous- Time Signal Processing. Low Voltage Signal Processing. Current- Mode Signal Processing: Continuous- Time Signal Processing, Sampled-Data Signal Processing, Switched-Current Data Converters. Analog Filters. Statistical Modeling and Simulation, Correlations and Principal Component Analysis, Statistical device Modeling, Statistical Circuit Simulation, Analog Layout.

References:

1. Mohammed Ismail, Analog VLSI : Signal and Information Processing, McGraw-Hill, 1994.
2. R.Schaumann, M.S.Ghausi, Kenneth R Laker, Design of Analog Filters Passive, Active RC, and Switched Capacitor, Prentice Hall, 1995.
3. T Deliyanis, Y.Sun and J.K.Fidler, Continuous-Time Active Filter Design, CRC Press,1999.
4. P.V.Anand Mohan, Current-mode VLSI Analog Filters: Design and Applications, Birkhauser, 2003.

ECE 5004 CAD TOOLS FOR VLSI [4 0 0 4]

Graph Theory, Graph optimization Problems and Algorithms. Programmable logic devices, FPGA Classification. Architectural Synthesis, Scheduling, Different types of scheduling with and without resource constraint algorithms. Two level combinational logic synthesis and optimization; Exact and heuristic method. Fault Simulation-Automatic test pattern generation (ATPG) techniques, Design for Testability.

References:

1. Giovanni De Michelli: Synthesis and Optimisation of Digital Circuits, Tata-McGraw Hill, New Delhi,2008.
2. Gary D. Hachtel, Fabio Somenzi, Logic Synthesis and Verification Algorithm, Kluwer Academic Publication, Boston,2002.
3. M.J.S.Smith, Application Specific ICs, Addison Wesley,2002.

ECE 5005 CODING THEORY [4 0 0 4]

Information – entropy, information rate, classification of codes, text, audio and speech coding. source coding: image and video. Error control coding: block codes, cyclic codes; syndrome calculation, encoder and decoder, CRC, convolutional codes; sequential search and Viterbi algorithm; turbo coding.

References:

1. R Bose, Information Theory, Coding and Cryptography, TMH 2007
2. Fred Halsall, Multimedia Communications: Applications, Networks, Protocols and Standards, Pearson Education Asia, 2002
3. S Gravano, Introduction to Error Control Codes, Oxford University Press 2007
4. Mark Nelson, Data Compression Book, BPB Publication 1992.
5. Watkinson J, Compression in Video and Audio, Focal Press, London, 1995.

ECE 5006 CRYPTOGRAPHY & NETWORK SECURITY [4 0 0 4]

Classical Encryption Techniques. Public-Key Cryptography and RSA.Key Management and Distribution: Wireless Network Security: Security Technology Firewalls and VPNs; Access control. Firewalls. Virtual Private Networks. Intrusion Detection and Prevention Systems. Honeypots, Honey-nets and Padded cell systems. Scanning and analysis tools. Biometric access controls

References:

1. William Stallings, Cryptography and Network Security, Pearson 6th edition. 2004
2. M. E. Whitman and Herbert J. Mattored, Principles of Information Security, Information Security Professional, Fourth edition. ,2011.
3 .K. Pachghare, Cryptography and Information Security. PHI Learning, 2015

ECE 5007 DATA COMPRESSION [4 0 0 4]

Compression techniques, modeling and coding. Information theory and coding; Prediction with partial match, the Burrows-Wheeler transform, CALIC, JPEG-LS, multi resolution approaches, Facsimile encoding. Distortion criteria, models, The quantization problem, Vector spaces, image compression and audio compression techniques. Filters, sub band coding algorithms, bit allocation, Application to speech coding, audio coding, and image compression, wavelets.

References:

1. Khalid Sayood, Introduction to Data Compression, Addison Wesley. 2000.
2. David Salomon,Data Compression, 2nd Edn., Springer,2000.
3. Toby Berger, Rate Distortion Theory: A Mathematical Basis for Data Compression,PrenticeHall, 1971.
4. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory, John Wiley & Sons, Inc,1991.
5. Ali N. Akansu, Richard A. Haddad, Multi resolution signal decomposition: Transforms, Subbands and Wavelets, Academic Press, 1992.

ECE 5008 DETECTION & ESTIMATION THEORY [4 0 0 4]

Classical detection and estimation theory and techniques, Qualities of good estimators, Cramer-Rao bound. Signal representation; Karhunen-Loeve series expansion method. Detection of signals and signal parameter estimation. Applications to binary digital communication systems. Signal detection in discrete time. Estimation of signal parameters; Detection of signals in colored noise. Filtering techniques, Wiener-Hopf equations.

References:

1. Vincent Poor H, An Introduction to Signal Detection and Estimation, Springer, Second Edition, 1994
2. Van Trees H L, Detection Estimation and Modulation Theory – Part I,JohnWiley, New York, 2002.
3. MouradBarkat,Signal Detection and Estimation, Artech House, Second Edition, 2005

ECE 5009 DIGITAL IMAGE PROCESSING [4 0 0 4]

Image Acquisition System, Image Sampling and Quantization; Color Models, Pseudo and Full-Color Image processing; Point Processing, Spatial operations, Smoothing and sharpening spatial filters. 2D DFT; Transform Operations, Smoothing and sharpening using frequency domain filters, Homomorphic Filtering. Image Degradation / Restoration Process, Detection of Discontinuities, Image Compression and standards, Wavelets and its applications in Image Processing.

References:

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson, 2008.
2. Anil K Jain, Fundamentals of Digital Image Processing, Pearson, 2001
3. W. K. Pratt, Digital Image Processing, Wiley 2010

ECE 5010 DIGITAL SPEECH PROCESSING [4 0 0 4]

Anatomy and Physiology of speech production, Acoustic theory of speech production, Uniform lossless tube model, Effects of losses in the vocal tract, Digital models for speech signals. Time-dependent processing of speech; Short time Auto-correlation, Pitch period estimation. Short Time Fourier Transform Analysis, Speech redundancies, Speech Synthesis, Feature Extraction; Artificial Neural Networks for speech recognition.

References:

1. Rabiner L.R, Schaffer R.W, Digital Processing of Speech Signals, Prentice Hall, NJ, 2007.
2. Thomas F. Quatieri, Discrete-time Speech Signal Processing-Principles and Practice, Pearson Education Inc, 2004.
3. Douglas O' Shaughnessy, Speech Communications: Human and Machine Reading, Addison-Wesley. 2nd edition, 1999.
4. Deller J.R, Proakis G.J and Hansen J.H.L, Discrete Time Processing of Speech Signals, IEEE Press. 2000.
5. Rabiner L.R and Jaung, Fundamentals of Speech Recognition, Prentice Hall. 1993.

ECE 5011 EMBEDDED SYSTEM DESIGN [4 0 0 4]

Characteristics, Classification, Model of embedded system. Embedded hardware; Embedded Firmware design and development. Hardware-Software Co-Design. Computational models, Unified modelling language, Hardware software trade-offs. Operating systems, Inter process communication, Task synchronization, Semaphores, Priority inversion, Device drivers, Scheduling algorithms. Packaging, Enclosure design and development. Embedded Product Development Life Cycle.

References:

1. Shibu K.V. Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Lyla.B.Das,Embedded Systems, An Integrated Approach, Pearson Ed, 2013
3. Abraham Silberschatz,Peter Baer Galvin and Greg Gagne, Operating System Concepts, 7th Edition Wiley Higher Education, 2005
4. Hermann Kopetz, Real-time systems: design principles for distributed embedded applications, Kluwer Academic publishers, 2002

ECE 5012 HIGH SPEED DIGITAL DESIGN [4 0 0 4]

High speed logic gates;Measurement Techniques. Transmission Lines: Shortcomings of ordinary point-to-point wiring, effects of source and load impedance, Ground Planes and Layer Stacking; Terminations and Vias; Power Systems: distribution problems. Connectors, Special Connectors, Ribbon Cable.Clock Distribution, Using canned clock oscillators, Clock jitter

References:

1. Howard Johnson, Martin Graham, High-Speed Digital Design, A handbook of black magic, Pearson Education, 2008.
2. Stephen H. Hall & Howard L. Heck, Advanced Signal Integrity for High-Speed Digital Designs, John Wiley & Sons, 2009
3. William J Dally & John W Poulton, Digital Systems Engineering, Cambridge University Press, 1998
4. Eric Bogatin, Signal and Power Integrity- Simplified, 2ndEdition, Prentice Hall, 2010

ECE 5014 MEMS TECHNOLOGY [4 0 0 4]

Background of MEMS, Bulk micromachining, surface micromachining, Micro-cantilevers, design of MEMS sensors, RF MEMS devises, Biosensors, MEMS device packaging

References:

1. Stephen D.Senturia Microsystem design, Kluwer Academic publications, 2001
2. Marc Madou, Fundamentals of Microfabrication, CRC Press, 1997
3. H.Bao, Micromechnanical Transducers: pressure sensors, accelerometers, and gyroscopes, Elsevier, NewYork 2000
4. Gabriel M Rebeiz, RF MEMS Theory, design and technology. Wiley Inter science,2003
5. Sergey Y. Yurish, Mearia Teresa S.R.Gomes, Smart sensors and MEMS, Kluwer Academic Publishers, 2003

ECE 5013 LARGE AREA MICRO ELECTRONICS [4 0 0 4]

Non-crystalline semi-conductor basics, Difference between, amorphous, polycrystalline and micro /nano crystalline hydrogenated silicon (a-Si:H), Thin Film transistor, LEDs, Large Area Image Sensor Arrays, Thin Film Position Sensitive Detectors. Field emission displays. Introduction to organic semiconductors - structure and geometry, stretchable and conformal electronics.

References:

1. Richard Zallen, The Physics of Amorphous solids, Wiley, 2007.
2. Sanjiv Sambandan, CIRCUIT DESIGN- Techniques for Non-CrystallineSemiconductors, CRC press, 2013.
3. Robert A. Street , Technology and Applications of Amorphous Silicon,. Springer-Verlag New York, LLC Series: Series in Materials Science, 2004.
4. A.Madan & M.P.Shaw, The Physics and Technology of Amorphous silicon, Elsevier Science & Technology books, 2012.
5. Takao Someya, Stretchable Electronics, Wiley-VCH; 1Edition, January 29, 2013.

ECE 5015 MICROWAVE AND MILLIMETER WAVE ANTENNA [4 0 0 4]

Millimeter Wave Technology, Microwave and Millimeter Wave Systems, Guiding Structures, Metamaterials. Millimeter Wave Antennas: Path Loss and Antenna Directivity, Antenna Beam width, Maximum Possible Gain-to-Q, Polarization, Beam Steering Antenna, Millimeter Wave Design Consideration, Millimeter Wave Propagation, Fifth-generation systems

References:

1. Duixian Liu, Ulrich Pfeiffer, JanuszGrzyb and Brian Gaucher, Advanced Millimetre-wave Technologies: Antennas, Packaging and Circuits , Wiley, 2009
2. Sergey M. Smolskiy, Leonid A. Belov and Victor N. Kochemasov, Handbook of RF, Microwave, and Millimetre-Wave Components, Artech House Microwave Library, 2013
3. Kao-Cheng Huang, Zhaocheng Wang, Millimetre Wave Communication Systems, Wiley, 2011
4. Shiban K. Koul, Millimetre Wave and Optical Dielectric Integrated Guides and Circuits, Wiley-Inter science, 1st edition, 200.
5. David M. Pozar, Microwave and RF Design of Wireless Systems, Wiley, 2000.

ECE 5016 NANO PHOTONICS [4 0 0 4]

Light generation by nanostructures, semiconductor quantum wells, nanocrystals, nanowires.

Light propagation in nano structures, Photonic crystals, dielectric periodic structures. Surface Plasmon, transmission through sub wave length hole, sub wave length waveguides. Near-field optics, Nano-photonics.

References:

1. Lukas Novotny and Bert Hecht, Principles of Nano-Optics, Cambridge University Press, 2012.
2. HerveRigneault, Jean-Michel Lourtioz, Claude Delalande and Juan Ariel Levenson, Nanophotonics, Wiley, 2006.
3. Mark L. Brongersma and Pieter G. Kik, Surface Plasmon Nanophotonics, Springer, 2006.
4. P.N. Prasad, Nanophotonics, Wiley-Interscience, 2003
5. John D. Joannopoulos, Robert D. Meade and Joshua N. Winn, Photonic Crystals, MIT Press, 2007

ECE 5017 NONLINEAR FIBER OPTICS [4 0 0 4]

Nonlinear optical effects in crystals. Pulse propagation through optical fibers. Third order dispersion, dispersion management. SPM induced spectral broadening, higher order nonlinear effects, optical solitons, XPM. Stimulated Raman and Brillouin scattering. Parametric processes.

References:

1. G. P. Agarwal, Nonlinear Fiber Optics, Academic Press, 2007.
2. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, 2007
3. G. P. Agarwal, Applications of Nonlinear Fiber Optics, Academic Press 2008.
4. R. W. Boyd, Nonlinear Optics, Academic Press 2008

ECE 5018 QUANTUM INFORMATION SCIENCE [4 0 0 4]

Classical Computation, Turing Machines and Circuits, Information, Erasure, Reversibility.

Single Quantum Bits. Multiple Quantum Bits, Entanglement. Measurements, EPR-Bell Theorem. Quantum Transformations: Reversible Gates, Quantum Circuit Model. Quantum Algorithms: Deutch-Jozsa's and Simon's Problems, Subsystems. Error Corrections.

References:

1. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2014 (Paperback edition).
2. Giuliano Benenti, Giulio Casati, and Giuliano Strini, Principles of Quantum Computation and Information, Volumes I and II,World Scientific, 2004.
3. Kaye, Laflamme, and Mosca, An Introduction to Quantum Computing, Oxford University Press, 2007.
4. Nielsen and Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2011.

ECE 5019 RADAR SYSTEMS [4 0 0 4]

Radar theory, range equation, transmitters, antennas. Tracking radar, detection and extraction, SNR. Duplexers, Doppler effect, High resolution radars. Electronic counter measure, Case studies.

References:

1. M.I.Skolnik, Introduction to Radar Systems, 3rd Ed., McGraw Hill, 2003.
2. Peyton Z. Peebles Jr., Radar Principles, John Wiley, 2004.
3. Edde Byron, Radar: Principles, Technology, Applications, Prentice-Hall education, 2004.
4. David Barton, Radar system analyses and Modeling, Artech house, 2005.

ECE 5020 RF MICROELECTRONICS CHIP DESIGN [4 0 0 4]

RF circuit design, Basic RF modules, Passive and active RF components, RF power amplifier, impedance matching, low noise amplifier (LNA), RF Filters, oscillators, mixers, modulators, detectors, and synthesizers.

References:

1. Thomas H. Lee Design of CMOS Radio-Frequency Integrated Circuits Cambridge University press, 2003.
2. Behzad Razavi RF Microelectronics, Prentice Hall International Publisher, 1998.
3. W. Alan Davis, Krishna K. Agarwal, Radio Frequency Circuit Design, John Wiley & Sons Inc., 2001. Cotter W. Sayre
4. Complete Wireless Design, McGraw-Hill Professional Publisher, 2008.
5. John M. W. Rogers, John W. M. Rogers, Calvin Plett, Radio Frequency Integrated Circuit Design ,Artech House Publishers, 2010.

ECE 5021 SEMICONDUCTOR DEVICE PHYSICS [4 0 0 4]

Review of Quantum mechanics, crystalline solids and energy bands, Fundamentals of semiconductor physics, Device Physics - Diode, Schottky diode, Tunnel diode, Transistors; MOS Structures, Semiconductor measurements.

References:

1. S. Selberherr, Analysis and Simulation of Semiconductor Devices, Springer-Verlag, 1984.
2. J. P. McKelvey, Introduction to Solid State and Semiconductor Physics, Harper and Row and John Weathe Hill, 1966.
3. D.K. Schroder, Semiconductor Material and Device Characterization, John Wiley, 1990.
4. S. M. Sze, Physics of Semiconductor Devices, 2nd edition John Wiley, 1981.
5. M AAchuthan& K N Bhat, Fundamentals of Semiconductor Devices Tata Mc Graw Hill.

ECE 5022 SPREAD SPECTRUM COMMUNICATION [4 0 0 4]

Direct sequence and frequency hop spread spectrum systems. Hybrid direct sequence/frequency hop spread spectrum. Sequence generators. Spread spectrum communication system model, diversity reception in fading channels, cellular radio concept, single and multicarrier CDMA.

References:

1. R. L. Peterson, R. E. Zeimer and D. E. Borth, Introduction to Spread Spectrum Communications, Pearson, 1995.
2. J. D. Proakis & M. Salehi, Digital Communication, McGraw Hill, 2008.
3. A. J. Viterbi, CDMA: Principles of Spread Spectrum Communications, Addision Wesley, 1995.
4. S. Verdu, Multiuser Detection, Cambridge University Press, 1998

ECE 5023 SYSTEM ON CHIP DESIGN [4 0 0 4]

SoC architecture, design issues; SoC design flow; logic cores, memory and analog cores; Design validation, Testing, embedded memories, analog and mixed signal core. Low power architecture, Subsystem design principles, Floor planning, Off- chip connections, RTL design, High level synthesis, System on –chips Embedded CPUs, Hardware/ Software Co –Design.

References:

1. RochitRajsuman, System – on – a – Chip Design and test, Artech House, Bosten , London, ed., 2000
2. Peter J. Ashenden, Jean P. Mermet, Ralf Seepold, System-on-chip

methodologies & design languages, Boston: Kluwer Academic Publishers, 2001

3. Wayne Wolf, Modern VLSI Design: System - on- Chip Design, Pearson, 2005
4. Michael Keating, Pierre Bricaud, Reuse methodology manual for system-on-a- chip designs, Boston: Kluwer Academic Publishers, 2001
5. Steve Furber, ARM System-on-Chip Architecture, 2nd Edition, Additon-Wesley professional, 2001.

ECE 5024 TIME-FREQUENCY AND WAVELET TRANSFORMS [4 0 0 4]

Time-frequency analysis and wavelet transforms. STFT. Two-channel filter bank and analysis, Quadrature mirror and conjugate quadrature filters, Haar transforms. Daubechies four-coefficient wavelet. Sampling. CWT, DWT, filter banks: Signal decomposition. parametric wavelets, Orthogonality conditions and parameterization, poly phase matrix and recurrence relation. Biorthogonal wavelets, Applications.

References:

1. P. S Addison, The illustrated Wavelet transform Handbook, Institute of Physics Publishing, 2002.
2. C S Burrus, A Gopinath, and HaitaoGuo, Introduction to wavelets and wavelet transforms, Prentice-Hall, 1998.
3. K P Soman and K. I. Ramachandran, Insight into Wavelets from theory to practice, Prentice-Hall of India, 2005.

ECE 5025 VLSI PHYSICAL DESIGN AND VERIFICATION [4 0 0 4]

ASICs, design flow, Transistor resistance and capacitance, timing analysis; Synopsys Prime time tool for STA, Clock tree Synthesis, Power grid analysis. Physical design, Algorithms for design automation, Clustering, System partitioning. Chip planning, Floor Planning, Placement & Routing, Algorithms, Transmission line effects and Interconnect modeling. Verification, Verilog scheduling and execution semantics. Combinational equivalence checking, modeling sequential systems, model checking, Simulator architectures.

References:

1. Weste N. and Harris D, CMOS VLSI Design: A Circuits and Systems Perspective, 4th ed. Pearson, 2010.
2. S. Sait, H. Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific, 1999
3. William K. Lam, Hardware Design Verification: Simulation and Formal Method-Based Approaches, Prentice hall PTR, 2005
4. Pallab Dasgupta, A Roadmap for Formal Property Verification, Springer, Neetherland, 2006
5. Smith M.J.S, Application Specific Integrated Circuits, Addison Wesley, 1997

ECE 5026 VLSI TESTING & TESTABILITY [4 0 0 4]

Digital and analog testing, Controllability and observability, Design-for-test, Test process and ATE, Fault modeling. Testing of combinational and sequential circuits. Test optimization and fault coverage. Testability - adhoc and structured approaches, Boundary scan. Signatures and Built-in self test, Reed-Muller and spectral coefficients, Signature analysis and Onlineself test.

References:

1. M. L. Bushnell and V. D. Agrawal, Essentials of testing for digital, memory and mixed-signal VLSI circuits, Boston: Kluwer Academic Publishers, 2013.
2. Miczo, Digital Logic Testing and simulation. New York: Harper & Row, 2003.
3. P. K. Lala, Fault Tolerant & Fault Testable hardware Design, BS Publications, 2013
4. Stanley L. Hurst, VLSI Testing: digital and mixed analogue digital techniques, Inspec/IEEE, 1999.
5. M. Abramovici, M. A. Breuer, and A.D. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1994

OPEN ELECTIVES

ECE 5051 ARM PROCESSOR AND APPLICATIONS [3 0 0 3]

ARM Embedded systems, Processor Fundamentals, Instruction Set, Thumb Instruction Set. Cortex-M0 architecture- Memory System, MMU, Interrupts and Exceptions. Cortex-M0 OS support features; Cortex-M0 fault handling; Application programming.

References:

1. Andrew Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Elsevier, Morgan Kaufmann publisher, 2004.
2. Steve Furber, ARM System-on-Chip Architecture, 2nd Edition, Additon-Wesley professional, 2001.
3. Joseph Yiu,The Definitive Guide to the ARM Cortex-M0, Elsevier, Newnes, 2011.
4. Dr Alexander G. Dean, Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach, ARM Education Media, 2017.

ECE 5052 NANO ELECTRONICS [3 0 0 3]

Nanomaterials, Nanostructured materials, Capabilities, physical fundamentals. Scaling principles, limits to scaling, power constrained scaling limits. Electronic transport in 1,2 and 3 dimensions- Quantum confinement. Electronic and optoelectronic properties of molecular materials. Spin tunneling devices, Ferroelectric random access memory, semiconductor sensor array. Nanotechnology for biological system & bio-sensor applications.

References:

1. V. Mitin, V. Kochelap, M. Stroscio, Introduction to Nano-electronics, Cambridge University Press, 2008.
2. Rainer Waser, Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH,2003.
3. Karl Goser, Peter Glosekotter, Jan Dienstuhl, Nano-electronics and Nano-systems, Springer, 2004.
4. SadamichiMaekawa, Concepts in Spin Electronics, Oxford University Press, 2006.
5 Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Wiley-VCH, 2006.

ECE 5053 NEURAL NETWORKS & FUZZY LOGIC [3 0 0 3]

Biological neurons, Mc-culloch Pitt's model, Feed forward and Feedback network, Supervised and unsupervised learning. learning rules. Classifiers; Discrete time and gradient type, Hopfield networks, Unsupervised learning methods; cluster discovery network, Counter propagation networks. kernel methods. Fuzzy Logic: fuzzy systems, membership functions, classical sets and fuzzy sets, fuzzy set rules. Fuzzy relations, Approximate reasoning. Fuzzy inference engine, Fuzzifiers, Defuzzifiers, Neuro fuzzy systems, with GA optimization

References:

1. Jacek M Zurada, Introduction to artificial Neural Systems, Jaico publication. 2006
2. Simon Haykin, Neural Networks and Learning Machines, PHI edition private Limited,3rd edition, New Delhi, 2009
3. Li Xin Wang, Introduction to fuzzy systems and control, Prentice Hall publication, 1997
4. Timothy J Ross, Fuzzy Logic with Engineering Applications, Intl. Edition, McGraw Hill publication, 2008

ECE 5027 PRINTED ELECTRONICS [4 0 0 4]

Introduction to Printed Electronics and their Materials Systems, Emerging technologies, General applications, Carrier transport, doping, band structure, thin-film electronic devices.

Printed Electronics: Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, paper-based electronics, textile substrates, barrier materials. Thin-film Deposition techniques.

Device structure and performance: I-V characteristics, Mechanics of Thin films and Flexible Transistors: thin-film mechanics models, neutral plane, conformal electronics, mechanical modelling.

Solution-based Patterning Processes: Ink-jet printing, gravure, Roll-to-Roll printing, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning Contacts and Interfaces to Organic andInorganic Electronic Devices: Schottky contacts, defects, carrier recombination, effect ofApplied mechanical strain.

Displays, sensor arrays, memory devices, lab-on-chip, and photovoltaics.

References:

1. Wong, William S., Salleo, Alberto (Editors), Flexible Electronics: Materials and Application, Springer, U.S./India , 2009.
2. Guozhen Shen, Zhiyong Fan (Editor) - Flexible Electronics: From Materials to Devices World Scientific, U.S. 2016
3. Takao Someya (Editor) – Stretchable Electronics – Wiley International, U.S. – 2013

ECE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

Department of Humanities & Management

The Department of Humanities & Management, MIT was founded in May 2009. The department has two disciplines: Management and English. The department has expertise in System Dynamics Modeling and Simulation, Organizational Behavior, Econometrics and Marketing, Research Methodology, Linguistics, Philosophy, English Literature, German Language, Cultural Studies, and English Communication.

The modules delivered at the undergraduate and post-graduate courses aim at making the engineering students develop an awareness of social, cultural, economic, ethical and human values. The Department of Humanities & Management plays a distinctive role in moulding the careers of engineers, as it provides an opportunity for students to learn managerial skills, communication skills and group dynamics so as to make them fit into the multi-cultural environment of the industry.

Programs offered

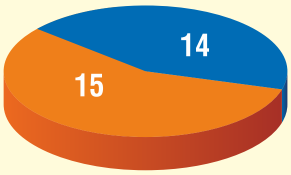
Post Graduate Program

- M.Tech in Engineering Management (1989)

PhD

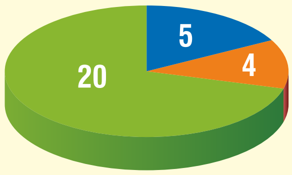
Faculty Strength

Qualification-wise



- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors

DEPARTMENT OF HUMANITIES & MANAGEMENT, MIT Manipal

M.Tech. ENGINEERING MANAGEMENT

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5153	Statistics, Probability and Reliability	4	0	0	4	HUM 5251	Operations Research	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	HUM 5252	Project Management	3	1	0	4
	HUM 5152	Accounting and Financial Management	3	1	0	4	HUM ****	Elective I	3	1	0	4
	HUM 5153	Managerial Economics	3	1	0	4	HUM ****	Elective II	3	1	0	4
	HUM 5154	Operations Management	3	1	0	4	HUM ****	Elective III	3	1	0	4
	HUM 5155	Organizational Behaviour and Human Resources Management	3	1	0	4	*** *****	Open Elective	3	0	0	3
	HUM 5161	Data Analysis Lab – I	0	0	3	1	HUM 5261	Data Analysis Lab – II	0	0	3	1
	HUM 5162	Modeling and Simulation Lab	0	0	3	1	HUM 5262	Enterprise Resource Planning Lab	0	0	3	1
							HUM 5263	Project Management Lab	0	0	3	1
		Total	**17**	**4**	**9**	**24**		**Total**	**18**	**5**	**9**	**26**
II	THIRD AND FOURTH SEMESTER											
	HUM 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
HUM 5001	Complex Business Dynamics	HUM 5007	Management Information Systems
HUM 5002	Creativity and Innovation Management	HUM 5008	Marketing Management
HUM 5003	Enterprise Resource Planning	HUM 5009	New Venture Strategy
HUM 5004	International Business Management	HUM 5010	Strategic Management and Business Planning
HUM 5005	Knowledge Management	HUM 5011	Supply Chain Management
HUM 5006	Maintenance Management	HUM 5012	Technology Management

OPEN ELECTIVES			
HUM 5051	Risk Management and Insurance	HUM 5053	Total Quality Management
HUM 5052	Services Marketing	HUM 5054	Valuation of Real Estate Properties

SEMESTER I

MAT 5153 STATISTICS, PROBABILITY AND RELIABILITY [4 0 0 4]

Basics of Statistics, correlation coefficient, peakedness in context with industries and quality control problems. Dependent variables, independent variables and their significance. Probability of discrete and continuous variables. Distributions and their properties. Measures of probability and concepts of quality control. Applications of frequency distribution and probability, tests for goodness-of-fit. Reliability analysis.

References:

1. Blank Leland, "Statistical Procedure for Engineering, Management and Science", Mc-Graw Hill.
2. Angand Tang, "Probability Concepts in Engineering Planning and Design", Wiley International.
3. Kottegoda N.T., Rosso R., "Statistics, Probability and Reliability for Civil Engineers", Mc-Graw Hill.

HUM 5151 RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, Different techniques of Data analysis. Thesis Writing and Journal Publication: format of journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, (2005). Research Methodology: A Step-by-Step Guide for Beginners, SAGE.
2. Geoffrey R. Marczyk, David DeMatteo and David Festinger, (2004). Essentials of Research Design and Methodology, John Wiley & Sons.
3. John W. Creswel, (2004) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE.
4. Suresh C. Sinha and Anil K. Dhiman, (2006). Research Methodology (2 Vols-Set), Vedam Books.
5. C. R. Kothari, (2008). Research Methodology: Methods and Techniques, New Age International Publisher.

HUM 5152 ACCOUNTING & FINANCIAL MANAGEMENT [3 1 0 4]

Functions of accounting and its relevance to decision making. Preparation and analysis of financial statements to evaluate the health of an organisation. Capital budgeting and its relevance to managerial decision making. Estimating working capital requirements. Relevance of costing in a typical business environment.

References:

1. Narayanaswamy, R, (2011), "Financial Accounting: A Managerial Perspective", PHI Learning Pvt. Ltd.
2. Raman B.S, (1993), "Advanced accountancy", United Publications, Bangalore.
3. Prasanna Chandra, (2006), "Fundamentals of Financial Management", Tata Mc-Graw Hill Companies, New Delhi.
4. Riggs J. L., Bedworth D. D. and Randhawa S. U., (2004), "Engineering Economics", Tata McGraw – Hill Publishing Company Ltd., New Delhi.
5. Ramachandran T., (2001), "Accounting and Financial Management", Scitech Publications Pvt. Ltd. India.

HUM 5153 MANAGERIAL ECONOMICS [3 1 0 4]

Roles and responsibilities of a managerial economist. Analysing the demand and supply for a product and/or service in the market and predicting the consumer behaviour. Demand and Supply and Elasticity, Production and cost analysis, Applying concepts of short-run and long-run cost, economies and diseconomies of scale. Understanding the market structure to strategize for competitive market conditions. National Income, GDP, Inflation, International Trade theories, Modern Trade theory, Foreign exchange.

References:

1. Mehta P L., (2007), "Managerial Economics: Analysis Problems Cases", Sultan Chand & Sons, New Delhi.
2. Varshney R. L. and Maheshwari K. L., (1994), "Managerial Economics" Sultan Chand.
3. Mankiw G., (2008), "Principles of Economics", Cengage-Learning.
4. Samuelson P. A. and Nordhaus W. D., (2010), "Economics", Tata McGraw Hill

HUM 5154 OPERATIONS MANAGEMENT [3 1 0 4]

Concepts of operations management in a general manufacturing scenario. Demand forecasting Capacity planning in dynamic manufacturing and servicing requirements. Importance of aggregate planning and its implications. Scheduling the jobs in manufacturing and service sectors for optimal utilization of resources. Designing and developing an effective inventory management system.

References:

1. Krajewski L. J. and Ritzman L. P., (2002), "Operations Management: Strategy and Analysis", 6th ed., Pearson Education.
2. Norman G. and Greg F., (2005), "Operations Management", South West Learning.
3. Heizer J. and Barry R., (2006), "Operations Management", 8th ed., Prentice Hall.
4. Wild Ray, (2003), "Operations Management", 6th ed., Thomson Learning.
5. Panneerselvam R., (2006), "Production and Operations Management", Prentice Hall of India, New Delhi.

HUM 5155 ORGANISATIONAL BEHAVIOUR & HUMAN RESOURCE MANAGEMENT [3 1 0 4]

Concepts, scope, objectives, functions, roles, issues and challenges in OB and HRM. Individual, motivation, attitude, perception, attribution theories, group dynamics. Leadership theories, Organization culture, development, organization change management, training and development.

References:

1. Pareek Udai et al., (2002), "Human Resource Development in Asia: Trends and Challenges", Oxford and IBH Publishing.
2. Robbins, S. P. (2001), Organisational Behaviour: Concepts, Controversies and Applications Australia and New Zealand. Prentice Hall.
3. Luthans F., (2010), 12th Edition "Organisational Behaviour", Tata McGraw Hil: Singapore.

HUM 5161 DATA ANALYSIS LAB I [0 0 3 1]

Statistics: Application of standard statistical package for data analysis. Computing statistical measures - frequency tables, graphs, diagrams, normality check, identification of outliers, transformations. Descriptive statistics - Skewness, Kurtosis. Univariate analysis - Testing of hypothesis, parametric and nonparametric tests, bivariate correlations, simple linear regression, curve fitting. Multivariate analysis - Multiple regression analysis, data reduction techniques. Working on the time series models. Quality control: Calculate average, sample standard deviation, sample median, and quartiles of a randomly sampled data using standard packages. Quality improvement in the modern business environment and introduction to statistical computing, methods and philosophy of statistical process control, control charts for variables and attributes, process and measurement system capability, acceptance sampling for attributes. Conduct quality exercise and plotting different charts. Validating the methods carried.

References:

1. Gerber S. B. and Finn K. V (2006). "Using SPSS for Windows – Data analysis and graphics", Springer.
2. Zagumny M. (2001). "The SPSS Book: A Student Guide to the Statistical Package for the Social Sciences", iUniverse.
3. Field A. (2012). "Discovering statistics using SPSS for Windows", SAGE publications.
4. R.A Johnson and D.W. Wichern, (1992). "Applied Multivariate Statistical Analysis", PHI, New Delhi.
5. Montgomery D. C (2013). Introduction to Statistical Quality Control, 7th ed., John Wiley & Sons, Inc., New York.

HUM 5162 MODELING & SIMULATION LAB [0 0 3 1]

System Dynamics: Dynamics of multiple loop systems, the modeling process, structure and behavior of systems, tools for systems thinking, causal loop diagram, stock and flow diagram, dynamics of simple structures, dynamics of growth, S-shaped growth, delays, path dependence, co-flows and aging chains, modeling decision making, formulating nonlinear relationships, instability and oscillation, and model testing. Design of Experiments: Techniques of collecting experimental data, experimental designs, corresponding methods of the analysis by means of the linear model, simple comparative experiments, single factor experiments, randomized blocks, Latin square designs and extensions, factorial designs, 2 ^ k designs, confounding and blocking in 2 ^ k designs, 2-level fractional factorial designs, 3-level and mixed-level factorials and fractional factorials, regression models, response surface methodology, random effects models, and validating the experimental results.

References:

1. Montgomery D. C., (2010) "Design and Analysis of Experiments", 7th ed., John Wiley & Sons.
2. Fisher R. A., (1966), "The Design of Experiments", 8th ed., Oliver and Boyd, Edinburgh.
3. Hinkelmann K. and Kempthorne O., (1994), "Design and Analysis of Experiments", John Wiley & Sons.
4. Sterman. J (2017). "Business Dynamics", Mc Graw Hill Education.

SEMESTER II

HUM 5251 OPERATIONS RESEARCH [3 1 0 4]

Applying the concepts of decision theory and risk analysis in managerial problems. Linear programming technique for manufacturing and service situations. Resolving transportation, assignment and traveling salesman problems in organisational situations. Application of dynamic programming and queuing theory in decision making. Monte-Carlo simulation in system analysis.

References:

1. Taha H. A., (2002), "Operations Research" 7th ed., Pearson Education.
2. Sharma S. D., (2005), "Operations Research", 14th ed., Kedar Nath Ramnath Publications.
3. Vohra N. D., (2007), "Quantitative Techniques in Management", TMH, New Delhi.
4. Wagnor H. M., (1993), "Principles of Operations Research", Prentice Hall of India Private Ltd.
5. Philips, Ravindran, and Solberg., (2006), "Operations Research: Principles and Practice", 2nd ed., John Wiley and Sons.

HUM 5252 PROJECT MANAGEMENT [3 1 0 4]

Relevance of project management in monitoring, controlling and executing a project. Defining the goals, objectives and scope of the project. Designing the project and work breakdown structure, and building the project teams. Optimizing the resources using project evaluation and review technique and critical path method. Estimating project time and cost budgeting. Dealing with situational factors that influence execution of the project. Formulation and evaluation of a project.

References:

1. Gray C. F., Larson E. W. and Desai G. V., (2009), "Project Management - The Managerial Process", Tata McGraw Hill.
2. Prasanna C., (2002), "Projects-Planning, Analysis, Financing, Implementation and Review",
3. Vasant D., (2000), "Project Management & Entrepreneurship", Himalaya Publishing House, Mumbai.
4. Nicholas J., (2002), "Project Management for Business & Technology", Pearson Education, Delhi.

HUM 5261 DATA ANALYSIS LAB II [0 0 3 1]

Structural Equation Modelling: Develop a conceptual model so as to analyse and evaluate the measurement, specification, identification and modification, testing of path analysis. Apply the model fit indicators to fit conceptual model with validation. Analytical Hierarchy Process: Developing multi criteria decision modelling in a business scenario, gauge multiple criteria decision and test analytic network, develop a pairwise comparison scale, measure inconsistency and sensitivity analysis. Utilize the validated model behaviour in decision criteria. Data Envelope Analysis: Conceptualizing linear, non-linear and mixed programming modules by measuring efficiency in a multiple input-output business scenario. Design input and output graphical representation to radial efficiency measures, interpretation of efficient targets and sets. Apply weight restrictions, assessing variables on a return scale and target setting, develop a super efficiency and category selection. Apply efficiency, productivity, and Malmquist index tools to validate.

References:

1. Schumacker R. E. and Lomax R.G. (2015), “A beginner's guide to Structural Equation Modelling”. Routledge, UK
2. Saaty, T. L., (1980), “The analytic hierarchy process: planning, priority, resource allocation”. McGraw-Hill, New York.
3. Cooper W. W., Seiford, L. M. and Tone K. (2006), “Introduction to Data Envelopment Analysis and its Us”, Springer, New York.
4. Thanassoulis E., (2001), “Introduction to the Theory and Application of Data Envelopment Analysis”, Springer, US.

HUM 5262 ENTERPRISE RESOURCE PLANNING LAB [0 0 3 1]

Introduction to ERP software and its features, ERP functional modules and technical areas. Data management, programs and execution of business process transactions using ERP software. Functions of accounting and its relevance to decision making. Preparation and analysis of financial statements to evaluate the health of an organisation.

References:

1. Kumar V. G. and Venkitakrishnan N K., (2003), “Enterprise resource planning concepts and practice”, PHI Learning Pvt. Ltd.
2. Leon A., (2008), “ERP demystified”, Tata McGraw-Hill Education.
3. Brady J. A., Monk E. F. and Wagner B., (2001), “Concepts in Enterprise Resource Planning Thompson Course Technology”, USA.
4. Ray R., (2012), “Enterprise Resource Planning”, Tata McGraw-Hill Education Pvt. Ltd.
5. Raman B. S., (1993), “Advanced accountancy”, United Publications, Bangalore.

HUM 5263 PROJECT MANAGEMENT LAB [0 0 3 1]

Business Plan presentation, Project selection, Internal Rate of Return, NPV, IRR, Scheduling of resources, Project network, Estimating project time, cost budgeting, Project monitoring and control, sensitivity analysis., Application of project management tools with resource allocation for measuring the economies of scale.

References:

1. Abrams R., (2010), “Successful Business Plan Secrets and Strategies”. 5th ed. New York, Planning Shop.
2. Prasanna C., (2002), “Projects-Planning, Analysis, Financing, Implementation and Review”, Tate McGraw, Hill, New Delhi.
3. Vasant D., (2000), “Project Management & Entrepreneurship”, Himalaya Publishing House, Mumbai.
4. Clifford F Gray., (2013), “Project Management” Mc Graw Hill Education Pvt Ltd.
5. Gopalan M R., (Second Indian Edition), “Project Management” Wiley Publication.

SEMESTER III & IV

HUM 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflect additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

HUM 5001 COMPLEX BUSINESS DYNAMICS [3 1 0 4]

The laws of fifth discipline and its significances in an organizational culture, system archetypes and its relevance to systems thinking, understanding the five disciplines of building a Learning Organisation (LO). Studying the principles of openness, localness, manager's time, and work-life balance in a LO. Learning about complex systems, system dynamics modelling process, and its tools for system thinking. Analysing structure and behaviour of a complex system. Dynamics of simple structures, S-shaped growth, delays, and path dependence. Studying the complexities involved in manufacturing and supply chain system. Developing and analysing a system dynamics model for a real world system.

References:

1. Sterman J. D., (2004), “Business Dynamics: Systems Thinking And Modeling for a Complex World”, McGraw Hill, International Edition.
2. Senge P., (1990), “The fifth discipline, Currency Doubleday”, New York, NY.
3. Mella P., (2012), “Systems Thinking: Intelligence in Action: 2 (Perspectives in Business Culture)”, 1st ed., Springer Milan Publisher.
4. Ranganath B. J. and Rodrigues L. R., (2012), “System Dynamics: Theory and case studies”, 2nd Edition, IK Book Publishers, New Delhi.

HUM 5002 CREATIVITY AND INNOVATION MANAGEMENT [3 1 0 4]

Importance of creativity and innovation in current business scenario. Applying key principles of leadership for unlocking and nurturing creativity, and, managing and developing the creative organisation. Relevance of fostering creativity within the organization and the “human equation". Understanding tools for Problem-solving, ideation, brainstorming and lateral thinking. Discussion and analysis in innovative business modelling with relevant case studies. Importance of strategic considerations in developing technology and nurturing innovation. Systematic inventive thinking in globalized scenario. Conceptualize new product development process, product launch, marketing and diffusion of innovation.

References:

1. Maital S, and Shesadri. DVR, (2013), "Innovation Management: Strategies, concepts and tools for growth and profit", Sage Publications, New Delhi.
2. Maital S, and Shesadri. DVR, (2007), "Innovation Management – Text and cases", Sage Publications, New Delhi.
3. Trott P, (2008), " Innovation Management and New Product Development", Prentice Hall.
4. Kandwalla P, (1988), "Fourth eye – Excellence through creativity", SAGE publications, New Delhi.

HUM 5003 ENTERPRISE RESOURCE PLANNING [3 1 0 4]

Understanding the concepts of Enterprise Resource Planning (ERP) systems. Identifying the trade-off between capabilities, costs, and risks of enterprise systems. Developing different approaches to select, implement, and realize the benefits of enterprise systems. Studying the functional and technical modules of ERP. Identifying the types of data and information needs in major functional areas. Understanding different technologies related to ERP and its implementation in various industries.

References:

1. Ray R., (2012), "Enterprise Resource Planning", Tata McGraw-Hill Education Pvt. Ltd.
2. Kumar G. V. and Venkitakrishnan N. K., (2003), "Enterprise resource planning concepts and practice", PHI Learning Pvt. Ltd.
3. Leon A., (2014), "ERP demystified", Tata McGraw-Hill Education.
4. Brady J. A., Monk E. F. and Wagner B., (2001), "Concepts in Enterprise Resource Planning Thompson Course Technology", USA.

HUM 5004 INTERNATIONAL BUSINESS MANAGEMENT [3 1 0 4]

Understanding international business and identifying the impact of globalization and liberalization on international trade and its management. Multi-culturalism and the implications of convergence and divergence issues. Applying different trade theories for managing trade relations internationally. Understanding the functioning of World Trade Organization, international monetary system, and general agreement on trades and services for managing organizations globally, learning about GST in Global scenario.

References:

1. Grifin R. W. and Pustay M. W., (2008), "International Business", Addison -Wesley Publication.
2. Wild and Han., (2009), "International Business the Challenges of Globalization", Vangonotes Publishers.
3. Feraro G., (2009), "The cultural Dimension of International Business", Amazon.

HUM 5005 KNOWLEDGE MANAGEMENT [3 1 0 4]

Concepts of knowledge management and its impact on strategic management and organizational learning. Types of organizational knowledge and knowledge transfer modes. Knowledge management frameworks, tools and processes. Critical success factors of knowledge management and case studies of KM implementation in various industries.

References:

1. Leibold M., Probst, and Gibbert M., (2002), "Strategic Management in the Knowledge Economy - New Approaches and Business Applications", Public Wiley Publication.
2. Davenport T. H. and Prusak L., (2000), "Working Knowledge: How Organizations Manage What They Know", Harvard Business School Press.
3. Tiwana A., (2000), "The Knowledge Management Toolkit", New Jersey: Prentice-Hall.
4. Awad E. M. and Ghaziri H. M. (2007), "Knowledge Management". Dorling Kindersley.

HUM 5006 MAINTENANCE MANAGEMENT [3 1 0 4]

Importance of maintenance, distinction between repair and maintenance, maintenance as a business proposition, design, evaluation and methods of maintainability, Importance of preventive maintenance and reliability centred maintenance, significance of spare parts management, total productive maintenance as an approach to enhance plant efficiency, planning and scheduling shutdown maintenance, measurement of maintenance effectiveness.

References:

1. Venkataraman V., (2010), "Maintenance Engineering and Management", PHI Learning Private Limited, 978-81-203-3130-3.
2. Mishra R. C. and Pathak K., (2012), "Maintenance Engineering and Management", 2nd ed., PHI Learning Private Limited, ISBN; 978-81-203-4573-7.
3. Mohamed D., Jezdimir K, & Abdul R., (2011), "Hand Book of Maintenance Management and Engineering", Springer, Dordrecht H, ISBN: 978-1-84882-471-3.
4. Mobley K., Higgins L., and Darrin W., (2008), "Maintenance Engineering Handbok, 2nd ed, McGraw Hill Publications.

HUM 5007 MANAGEMENT INFORMATION SYSTEMS [3 1 0 4]

Systems approach to management information system. Understanding the importance of various information systems in manufacturing and service organisations. Role of management information in decision making. Development of a customised management information system to suit various client requirements and system implementation and maintenance.

References:

1. Gordon B. D. and Margrethe H. O., (2005), "Management Information Systems", McGraw-Hill, New York.
2. Kenneth L. and Price J. P., (2003), "Management Information Systems", Macmillan.
3. Jawadekar W. S., (2000) "Management Information System", Tata McGraw Hill.
4. Senn J. A., (2003), "Analysis & Design of Information System", McGraw Hill International Student Edition.

HUM 5008 MARKETING MANAGEMENT [3 1 0 4]

Marketing concept for the twenty-first century. Drivers of modern economy and the changes in the business practices. Developing market oriented strategies leading towards value creation and customer satisfaction. Relevance of modern marketing information system and database. Consumer behaviour, Identifying market segmentation, targeting and positioning of product or service. PLC strategies, applying competitive market differentiation tools to identify the pricing strategies. Developing distribution and promotion strategies.

References:

1. Kotler P., Kevil keller., Abraham Koshy and Mithileshwar Jha (2012), “Marketing Management – A South Asian Perspective, Planning, Implementation and Control”, Prentice Hall of India Private Limited, New Delhi.
2. “Marketing Management”, ICFAI, Hyderabad, 2003.
3. Varshney R. L. and Gupta S. L., (2004), “Marketing Management”, Sultan Chand & Sons, New Delhi.
4. Palmer A., (2000), “Principles of Marketing”, Oxford University Press, New York.

HUM 5009 NEW VENTURE STRATEGY [3 1 0 4]

Relevance of entrepreneurship, creativity, invention and innovation from market perspective. Market dynamics and business model dynamics for a new start-up. Understanding the factors influencing the consumer buying behaviour and its processes. Analysing a business and developing a business plan oriented towards the business idea. Government schemes, feasibility study, characteristics of entrepreneur, success and failure cases of entrepreneurs.

References:

1. Maital S. and Shesadri DVS., (2013), “Innovation Management: Strategies, concepts and tools for growth and profit”, Sage Publications, New Delhi.
2. Maital S. and Shesadri DVR., (2007), “Innovation Management – Text and cases”, Sage Publications, New Delhi.
3. Khalil T. M., (2000), “Management of technology”, McGraw Hill, Boston.
4. Bansal R., (2010), “Connect the dots” Eklavya Education Foundation, India.
5. Karl.H.Vesper (1980), New Venture Strategies, Prentice Hall Inc, NJ.

HUM 5010 STRATEGIC MANAGEMENT AND BUSINESS PLANNING [3 1 0 4]

Concepts of strategic management and its importance in a business environment, overview of strategic management process and its role in developing learning organization. Environmental analysis in a dynamic business setting for effective strategy formulation, role of corporate strategy and corporate governance in achieving organisational objectives. Strategic options and its implications towards business growth. Significance of analysis of industry, competition, and competitive advantage in the globalised market. Understanding the implementation, and control process in strategic planning and its evaluation criteria in an organisation.

References:

1. Thompson, (2012), “Crafting and Executing Strategy, the Quest for Competitive Advantage: Concepts and Cases”, 14th ed., McGraw-Hill, New Delhi.
2. Porter M. E., (1980), “Competitive Strategy”, Free Press, New York.
3. Barney J., (2014), “Gaining and Sustaining Competitive Advantage”, Prentice Hall of India,
4. Kazmi A., (2008), “Strategic Management and Business Policy” 3rd ed., McGraw-Hill, New Delhi.

HUM 5011 SUPPLY CHAIN MANAGEMENT [3 1 0 4]

Understanding of all the operational processes that create value for the firm. Identifying the key drivers of supply chain performance. Designing distribution networks for an effective supply chain. Evaluating strength and weakness involved in different modes of transportation, vehicle scheduling, role of information technology in supply chain. Understand the importance of coordination in supply chain, supply chain Integration, agile supply chain, green supply chain.

References:

1. Janat Shah., (2016) “Supply chain Management- Text and cases”, Pearson education.
2. Chopra S. and Meindl P., (2016), “Supply Chain Management. Strategy, Planning & Operation”, Pearson.
3. Handfield R. B. and Nichols E. L., (1999), “Introduction to Supply Chain Management”, Upper Saddle River, NJ: prentice Hall.
4. Simchi-Levi D., (2007), “Designing and Managing the Supply Chain”, Mcgraw-Hill College.
5. Monczka R., Handfield R., Giunipero L. and Patterson, J., (2011), “Purchasing and Supply Chain Management”. Cengage Learning.

HUM 5012 TECHNOLOGY MANAGEMENT [3 1 0 4]

Management of technology-description, scope and implications, technology strategy-need, importance, crafting technology strategy, strategic thinking and generic competitive strategies, targeted basic research-industry university partnerships, forecasting and planning technology, s-curve dynamics, kondratieff waves and long wave hypothesis. Managing innovation-introduction, competing through innovation: invention, innovation and entrepreneurship, types of innovation, approaches to innovation, choosing and profiting from innovation, managing innovation within firms. New product development-product strategy, technology life cycle, managing new product development teams. Managing intellectual property-technology transfer and strategic alliances, patents.

References:

1. Baltzan, P. (2012). “Business driven technology”, McGraw-Hill.
2. Schilling and Melissa. (2010). “Strategic Management of Technological Innovation”, 3rd Ed, McGraw-Hill. New York.
3. Gerald H Gaynor. (1996). “Handbook of Technology Management”, McGraw Hill, New York.
4. Frederick Betz. (1987). “Managing Technology”, Prentice Hall Publication, New Jersey.
5. Paul Trott. (2008). “Innovation Management and New Product Development”, Pearson Education.

OPEN ELECTIVES

HUM 5051 RISK MANAGEMENT AND INSURANCE [3 0 0 3]

Familiarize with the current practices of financial risk management. Analyses of various sources of risk. Evaluation of business and personal risk using insurance as a risk management tool. Identify the role of agents, corporate agents, brokers, third party administrators, loss assessors in insurance market. Understand risk management in connection with life, health, property, and liability insurance. Underwriting of Insurance policy, claims documents, investigation, arbitration, and procedure of loss assessment.

References:

1. Magee J.H. and Bickelhaupt D.L., (1964), "General Insurance - Irwin Series in Risk and Insurance".
2. Vaughan E.J. and Vaughan T., (2003), "Fundamentals of risk and insurance", Ninth Edition, WSE Wiley Publications, Asia.
3. Agarwal A. and Rao P.R., (2002) "Study on Distribution Functions in General Insurance & Role of Intermediaries".

HUM 5052 SERVICES MARKETING [3 0 0 3]

Customer focus, service marketing mix, and gap model of service quality and their relevance to service marketing. Understanding consumer behaviour and expectations of services in marketing research. Identifying strategies for service innovation, design challenges and standards. Application service supply chain through electronic channels and direct or company owned channels. Managing the integrated financial and economic service promises.

References:

1. Lovelock., (2011), "Services Marketing- People, Technology, Startegy", Pearson Education Singapore, ISBN- 9788131759394.
2. Zeithaml., (2011), "Services Management", McGraw-Hill Education India Pvt.Ltd - New Delhi, ISBN-0070700990
3. Rajendra N., (2010), "Services Marketing", 3rd edition, Tata McGraw Hill Education.
4. Verma H. V., (2011), "Services Marketing- Text and Cases", 2nd edition, Pearson Education, ISBN-9788131754474.
5. Shital V., (2013), "Services Marketing-Concepts and Case Studies", Dattsons Publishers

HUM 5053 TOTAL QUALITY MANAGEMENT [3 0 0 3]

Understanding dimensions of quality, role of employee involvement, team dynamics, motivation, and performance appraisal in process improvement, quality planning, quality costs. Strategic planning. Applying the seven tools of quality, statistical fundamentals to learn six sigma and control chart concepts. Understanding benchmarking process and quality function deployment in the current business scenario. Learning the International Standards Organization concepts and its importance and application.

References:

1. Besterfiled D.H. (2015), "Total Quality Management", Pearson Education in South Asia.
2. Evans J.R. and Lidsay W.M., (2002), "The Management and Control of Quality", South-Western (Thomson Learning).
3. Feigenbum.A.V., (1991), "Total Quality Management", McGraw-Hill.

HUM 5054 VALUATION OF REAL ESTATE PROPERTIES [3 0 0 3]

Understanding the market analysis and techniques of real-estate valuation. The application of different approaches to valuation: income approach, market approach, and cost approach. The role of valuation in real-estate investment and government regulation. Factors affecting value of a building. Valuation procedure for insurance claim, life interest in property, and troubled debt restructuring concept.

References:

1. Gandhi R.K., (2002), "Elements of Valuation of Immovable Properties", S R Gandhi Publisher, India.
2. Datta D.S., (2004), "Valuation of Real properties Principles and Practice", Eastern Law House Private Ltd.

Department of Information & Communication Technology

Established in the year 2001, the Department has developed itself as a center of excellence, providing opportunities for innovation and research, with well-equipped computer laboratories and dedicated faculty.

The students are given freedom to organize workshops or seminars and are encouraged to take part in co-curricular and extra-curricular activities without compromising the quality of learning. The academic curriculum for the courses offered in the Department and the technical skills of the students have been appreciated by the Industries who have visited MIT. Our alumni are working as Software Professionals in top Industries like Google, Microsoft, Oracle, Cisco, IBM, Intel, Samsung R&D, Honeywell, Flipkart, Toshiba, KPIT Cummins, Deloitte etc., These prospectus jobs offered per student testify the quality and excellence of the Department.

Programs offered

Under Graduate Programs

- B.Tech in Information Technology (2000)
- B.Tech in Computer and Communication Engineering (2013)

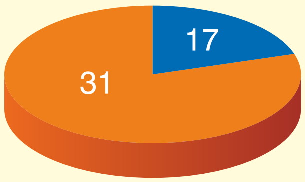
Post Graduate Programs

- M.Tech in Computer Networking and Engineering (2005)
- M.Tech in Software Engineering (2006)

PhD

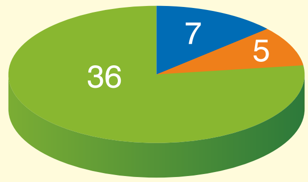
Faculty Strength

Qualification-wise

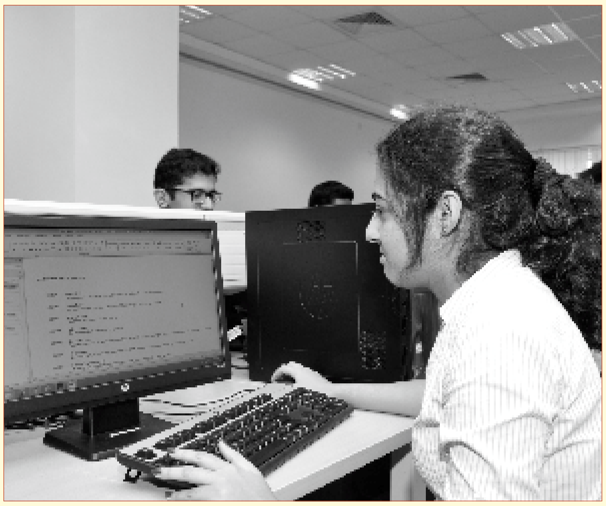


- PhD
- M.Tech/ME

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors



DEPARTMENT OF INFORMATION AND COMMUNIUCATION TECHNOLOGY, MIT Manipal

M.Tech. SOFTWARE ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5157	Probability and Stochastic Process	4	0	0	4	ICT 5251	Software Architecture and Testing	4	0	2	5
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ICT 5252	Software Quality Engineering	3	0	2	4
	ICT 5151	Advanced Data Structures and Algorithms	3	0	2	4	ICT ****	Elective I	3	0	2	4
	ICT 5152	Advanced Database Management Systems	4	0	2	5	ICT ****	Elective II	3	0	2	4
	ICT 5153	Mathematical Logic	4	0	0	4	ICT****	Elective III	4	0	0	4
	ICT 5154	Software Design	3	0	2	4	***.****	Open Elective	3	0	0	3
	ICT 5161	Advanced Programming Lab	0	0	3	1	ICT 5261	Advanced Technology Lab	0	0	3	1
	ICT 5162	Modeling and Verification Lab	0	0	2	1						
		Total	**19**	**0**	**14**	**25**		**Total**	**20**	**0**	**11**	**25**
	THIRD AND FOURTH SEMESTER											
II	ICT 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
ICT 5001	Big Data Technologies	ICT 5006	Intelligent Systems
ICT 5002	Cloud Computing	ICT 5007	Machine Learning
ICT 5003	Deep Learning	ICT 5008	Parallel Computation and Applications
ICT 5004	Formal Methods	ICT 5009	Software Project Management
ICT 5005	Information Retrieval		

OPEN ELECTIVES			
ICT 5051	Blockchain Technology and Applications	ICT 5053	Game Theory and Applications
ICT 5052	Cyber Security	ICT 5054	Real Time Systems

SEMESTER I

MAT 5157 PROBABILITIY AND STOCHASTIC PROCESS [4 0 0 4]

Random Variables, one and two dimensional random variables, probability density function, Expectation, variance covariance, correlation coefficient of random variables, uniform distributions, Functions of random variables, probability distributions of functions of random variables, conditional probability distributions of two dimensional random variables. Sampling, Estimation of mean and variance, Maximum likelihood estimate, interval estimation. Stochastic Process, Stationarity, Auto correlation, Markov models, Gaussian mixture models. Game Theory – two person zero sum game, various methods to solve zero sum games. Linear algebra – eigen values and eigen vectors, diagonalization, decomposition of matrices.

References:

1. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
2. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.
3. David C Lay, Linear Algebra and its Applications (3e), Pearson Publications
4. Hogg and Craig,Introduction to Mathematical Statistics, Mc.Millan company
5. Hamdy A.Taha – Operations Research McGraw Hill.

ICT 5151 ADVANCED DATA STRUCTURES & ALGORITHMS [3 0 2 4]

Performance analysis of algorithms, Advanced data structures- Trees, Binary trees, Balanced trees, Hashing, Priority queues, Searching and sorting, The disjoint set ADT, Path compression algorithms, Algorithm design techniques-Greedy, divide and conquer, Backtracking, dynamic programming, Branch and bound, randomized algorithms, NP completeness, Introduction to Parallel algorithms.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in Java, Pearson Education 2012
2. Sahni, Data structures, Algorithms and Applications in Java (2e), Silicon Press, 2004.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein., Introduction to Algorithms (3e), PHI Learning Pvt. Ltd., Eastern Economy Edition, PHI, 2010
4. Vipin Kumar, Anshul Gupta, George Karpis Ananth Grama, Introduction to Parallel Computing (2e), Pearson Education Limited, 2003.

ICT 5152 ADVANCED DATABASE MANAGEMENT SYSTEMS [4 0 2 5]

Centralized, Client-Server, Parallel and Distributed Systems, Overview of Relational Database Design, Query Processing and Optimization, Complex Data Types, Structured types, Inheritance in SQL, Table Inheritance, Array and Multiset Types in SQL, Implementing Object and Object-Relational Features, Data Partitioning, Interquery, Intraquery, Intraoperation, Interoperation Parallelisms, Distributed data storage, Transactions, Commit Protocols, Concurrency and Availability and Query Processing, XML, DDT, XML schema, Querying and Transformation, XPath, XQuery, Storage of XML data, Data Analysis and OLAP, Data Warehousing, Knowledge Discovery process, Data Mining , Association Rules Mining, Classification, Clustering Analysis, Spatial and Geographic Data, Active Databases, Multimedia Databases, Mobile Databases, Genome Data Management.

References:

1. Silberschatz, Korth and Sudarshan, Database System Concepts (6e), McGraw Hill, 2010
2. Ramez Elmasri and S B Navathe, Fundamentals of Database Systems (7e), Addison-Wesley, 2016
3. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques (3e), Morgan Kaufmann Publishers,2011
4. Arun K. Pujari, Data Mining Techniques(2e), Universities Press, 2001

ICT 5153 MATHEMATICAL LOGIC [4 0 0 4]

Propositional Logic: Natural Deduction Rules, Derived Rules, Normal Forms, Test for Satisfiability, SAT Solvers, Predicate Logic: Proof Rules of Predicate Logic, Semantics of Predicate Logic, Undecidability of Predicate Logic, Expressive Power of PL, Models, Temporal Logic: Introduction to LTL and CTL, Model Checking, Modal Logic: Modes of truth, Basic Modal Logic, Logic Engineering, Natural Deduction

References:

1. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems (2e), Cambridge University Press, 2007
2. Mordechai Ben-Ari, Mathematical Logic for Computer Science (3e), Springer, 2012
3. Elliot Mandelson,"Introduction to Mathematical Logic (5e), Chapman and Hall, 2009
4. ChristelBaier, Joost-Pieter Katoen and Kim G Larsen, Principles of Model Checking, MIT Press, 2008

ICT 5154 SOFTWARE DESIGN [3 0 2 4]

Introduction to software development cycle and software engineering – process models, devops, Requirement Analysis, Building analysis model, Scenario and Flow oriented modeling, Class based modeling. Software requirement specification document. Design Engineering-Design concepts, Architectural, Component level, Deployment level, Pattern based design. Object oriented analysis System use case modeling Basic structural modeling, Advanced structural modeling, Class and Object diagrams, Basic behavioral modeling, Interaction diagrams, collaboration and deployment diagrams, Use case diagram, Case studies-Real time System design.

References:

1. James Rumbaugh, Michael Bloha, Object Oriented Modeling and Design With UML (2e), Pearson Education, 2007.
2. Grady Booch, James Rumbaugh, Ivan Jacobson, The Unified Modeling Language User Guide (2e), Prime Publications, 2005
3. Pressman R., Software Engineering, A Practitioners Approach (8e), Tata McGraw Hill Publication, 2018.
4. Phillip A. Laplant, Seppo J Ovaska, Real Time Systems Design and Analysis: Tools for the practictioner (4e), IEEE Press, A John Weily & Sons Inc., Publications.2012.
5. Joakim Verona, Practical DevOps (2e), Packt Publications,May 2018

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

ICT 5161 ADVANCED PROGRAMMING LAB [0 0 3 1]

Learning and acquiring skill set to implement the given problem statement using programming language specified. Lab exercises includes Classes and Objects, Inheritance, Interface, ArrayList, Swings, JDBC and JSP. Students are expected to develop a standalone GUI based application and web application with suitable back end database.

ICT 5162 MODELING AND VERIFICATION LAB [0 0 2 1]

Students will be taught Prolog programming. Basics of temporal logic: LTL and CTL will be covered. Specification in LTL and CTL. NuSMV will be used as the model checking and verification tool. Alloy and TLA+ will be introduced.

SEMESTER II

ICT 5251 SOFTWARE ARCHITECTURE AND TESTING [4 0 2 5]

Introduction of Software Architecture and Architecture Patterns, Quality Attributes and Tactics, Architecture Documentation and Reconstruction, Architectural Details, Architectural Patterns, Service Oriented Architecture, Testing Fundamentals, Software Testing Strategies, Coverage Based and Boundary Testing Techniques, Control Flow and Data Dependency

References:

1. Bass Len, Clements Paul and Kazman Rick, Software Architecture in Practice (3e), SEI Series in Software Engineering, 2013
2. Jeff Tian, Software Quality Engineering: Testing, Quality Assurance and Quantifiable Improvement, John Willey and Sons Inc. 2006
3. Aditya Mathur, Foundation of Software Testing (2e), Pearson, 2013
4. Garland Jeff and Anthony Richard, Large Scale Software Architecture: A Practical guide using UML, Wiley Dreamtech India, 2003
5. Thomas Erl, Service Oriented Architecture, Concepts, Technology and Design, Prentice Hall, 2009.

ICT 5252 SOFTWARE QUALITY ENGINEERING [3 0 2 4]

Introduction to software Quality- Software Quality concept, review techniques; Software Quality Assurance- SQA tasks, goals, approaches to SQA, Plan; Software Quality Management and Models Modeling Process, Software Reliability Models; Software Measurement and Matrices- principles of measurement, Software Product Metrics, metrics for source code, design, analysis, testing, maintenance; Process Quality Management methods; Coding Standards- MISRA C rules, MISRA C++ rules; Software testing for Different architecture styles.

References:

1. Roger S. Pressman, Software Engineering A Practitioner's Approach (7e), Tata MacGraw Hill, 2010.
2. Robert T. Futrell, Donald F. Shafer, Lindl. Shafer, Quality Software Project Management (7e), Pearson, 2011.
3. Daniel Galin, Software Quality Assurance (1e), Person, 2010
4. Stephen H, Kan, Metrics and Models in Software Quality Engineering(2e), Addison Wesley, 2002

ICT 5261 ADVANCED TECHNOLOGY LAB [0 0 3 1]

The lab has been designed to have 2 components:

i. Hands on using a programming language (python)

ii. Design and implementation of a solution for a selected problem statement (a mini project)

Lab exercises focus on basics of python programming, lists, tuples, sets, dictionaries, control flows, functions, modules, regular expressions, object oriented programming, network, web and database programming, plots, image processing, machine learning, carrying out.

Mini project: Design and implementation of mini project .

SEMESTER III & IV

ICT 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

References:

1. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
2. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.
3. David C Lay, Linear Algebra and its Applications (3e), Pearson Publications
4. Hogg and Craig,Introduction to Mathematical Statistics, Mc.Millan company
5. Hamdy A.Taha – Operations Research McGraw Hill.

PROGRAM ELECTIVES

ICT 5001 BIG DATA TECHNOLOGIES [3 0 2 4]

Overview of Big data, Data Analysis, Hadoop, HDFS, Data ingestion using Fume and Scoop, MapReduce structure, Writing MapReduce programs, Hadoop Ecosystem: Pig, Hive, Working with Spark, Stream Data analytics: models, queries, NOSQL: properties, models, querying, Case Studies for big data analytics.

References:

1. Tom White, Hadoop: The definitive guide(3e), O'reilly, Yahoo Press, 2012.
2. Nataraj Dasgupta, Practical Big Data Analytics (1e), Packt publishing Ltd, 2018

3. Shashank Tiwari, Professional NOSQL (1e), Wiley India Pvt. Ltd., 2012
4. Bill Chambers and Matei Zaharia,Spark:The Definitive Guide (1e), Shroff/O'Reilly, 2018

ICT 5002 CLOUD COMPUTING [3 0 2 4]

Introduction to Cloud Computing, Challenges of cloud computing, Understanding Cloud Architecture and Services, Application Paradigms, Virtualization, Compute Virtualization, Storage Virtualization, Network Virtualization, Cloud Resource Management and Scheduling, Cloud Security, Cloud Application Development.

References:

1. Sehgal, Naresh Kumar, and Pramod Chandra P. Bhatt, Cloud Computing: Concepts and Practices, Springer, 2018.
2. Dan C Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, 2013.
3. Naveen Sabharwal and Ravi Shankar, Apache CloudStack Cloud Computing, Packt Publishing Ltd., 2013.
4. Mark C Chu-Carroll, Code in the Cloud, Pragmatic Bookshelf, 2011.
5. Barrie Sosinsky, Cloud Computing Bible, Wiley Publishing Inc., 2011.

ICT 5003 DEEP LEARNING [3 0 2 4]

Introduction, Mathematical Preliminaries, Machine Learning Basics, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Recurrent and Recursive Networks, Practical Methodology

References:

1 Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press 2016
2 Simon Haykin, Neural Networks and Learning Machines, Pearson, 2018
3 Charu C Agarwal, Neural Networks and Deep Learning, Springer 2018
4 Andrew Ng's Notes on Machine Learning from CS229

ICT 5004 FORMAL METHODS [4 0 0 4]

Software system formal mechanisms, including specification, validation, and verification. Formal specification for concurrent systems using temporal logics. Evolution of formalism to model certain system, Use of model checking and program verification tools for verification of concurrent software.

References:

1. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and reasoning about systems (2e), Cambridge University Press, 2007.
2. José Bacelar Almeida, Maria João Frade and Jorge Sousa Pinto, Rigorous Software Development: An Introduction to Program Verification, Springer, 2011.
3. Jean-Francois Monin and M.G.Hinchey, Understanding Formal Methods, Springer, 2003.
4. Christel Baier, Joost-Pieter Katoen and Kim Guldstrand Larsen, Principles of Model Checking, MIT Press, 2008.

ICT 5005 INFORMATION RETRIEVAL [4 0 0 4]

Boolean Retrieval, Term Vocabulary and Postings Lists, Dictionaries and Tolerant Retrieval, Index Construction and Index Compression, Scoring, Term Weighting and Vector Space Model, Computing Scores in a Complete Search Systems, Evaluation in Information Retrieval, Relevance Feedback and Query Expansion, Matrix Decomposition and Latent Semantic Index, Web Search Basics, Web crawling and indexes, Probabilistic Information Retrieval, Multimedia Information Retrieval.

References:

1. Christopher D.Manning, PrabhakarRaghavan and HinrichSchutze, Introduction to Information Retrieval (1e), Cambridge University Press, 2008.
2. Morgan and Claypool, Multimedia Information Retrieval, 2010.
3. David A Grossman and OphirFrieder, Information Retrieval : Algorithms and Heuristics (2e), Springer, 2004
4. Ian H Witten, Alistair Moffat and Timothy C.Bell, Managing Gigabytes: Compressing and Indexing Documents and Images (2e), Morgan Kaufmann, 1999
5. Amy N Langville and Carl D Meyer, Google's Page Rank and Beyond: The Science of Search Engine Ranking (1e), Princeton University Press, 2006

ICT 5006 INTELLIGENT SYSTEMS [3 0 2 4]

Introduction to Intelligent Systems (IS), Representation, Ontologies and Expertise, Search and Computational Complexity in IS, Constraints Satisfaction Problem, Logic-Based Chaining, Nonmonotonic Logic, Representing and Manipulating Uncertainty in IS, Fuzzy Systems

References:

1. Robert J. Schalkoff, Intelligent Systems: Principles, Paradigms, and Pragmatics (1e), Jones & Bartlett Learning, 2009
2. Yung C. Shin and ChengyingXu, Intelligent Systems: Modeling, Optimization, and Control (1e), CRC Press, 2009
3. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3e), Pearson Education India, 2015

ICT 5007 MACHINE LEARNING [3 0 2 4]

Introduction to Machine Learning, Mathematical Preliminaries, Supervised Learning: Logistic Regression, Generative Learning Algorithms, GDA, SVM, Model Selection, Ensemble Methods, Learning Theory: Bias/Variance tradeoff, Union, Chernoff and Hoeffding bounds, VC dimension , Unsupervised Learning: K-means, EM, GMM, Factor Analysis, PCA, ICA, Reinforcement Learning and Control: MDPs, Bellman Equation, LQR, LQG, and Q-learning.

References:

1. Kevin P Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012.
3. Christopher M.Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
4. Andrew Ng, CS229 Machine Learning, Autumn 2018, Stanford University

ICT 5008 PARALLEL COMPUTATION AND APPLICATIONS [3 0 2 4]

CPU and GPU architectures for parallel computation, Data parallelism and CUDA C, Data parallel execution model, CUDA memories, CUDA resource constraints and their impact on kernel execution performance, Parallel patterns, CUDA prepackaged libraries, Applications, More on CUDA and graphics processing unit computing, An introduction to OpenCL for CUDA programmers.

References:

1. David B. Kirk and Wen mei W. Hwu, Programming Massively Parallel processors A Hands on Approach (3e), Morgan Kaufman, 2016.
2. Tolga Soyata, “GPU Parallel Program Development Using CUDA”, CRC Press, 2018.
3. Bhaumik Vaidya, Hands-On GPU-Accelerated Computer Vision with OpenCV and CUDA: Effective techniques for processing complex image data in real time using GPUs (1e), Packt Publishing, 2018.
4. John Cheng, Max Grossman, and Ty McKercher, Professional CUDA C Programming, John Wiley & Sons, Inc.2014.
5. Shane Cook, CUDA Programming: A developer's guide to parallel computing with GPUs (1e), Morgan Kaufman, 2013.

ICT 5009 SOFTWARE PROJECT MANAGEMENT [3 0 2 4]

Software project management activities, methodologies, Management Principles, Management Control, strategic program management; Software process and process models, Effort estimation and cost estimation techniques; Project scheduling , risk management activities; Project concepts and management, Framework for management and control,; Software project staffing – managing people, team structure, organization behavior, communications.

References:

1. Bob Hughes, Mike Cotterell and Rajib Mall, Software Project Management (5e), Tata McGraw Hill, New Delhi, 2012.
2. Robert K. Wysocki, Effective Software Project Management, Wiley Publication, 2011.
3. Walker Royce, Software Project Management, Addison-Wesley, 2000.
4. Gopalaswamy Ramesh, Managing Global Software Projects McGraw Hill Education (India), Fourteenth Reprint 2013.

OPEN ELECTIVES

ICT 5051 BLOCKCHAIN TECHNOLOGY AND APPLICATIONS [3 0 0 3]

Introduction to technology stack: Blockchain, protocol, understanding how blockchain works. Introduction to consensus model. Architecture of decentralized application, Dapps development process and command, application model for Dapp, introduction to Dapp development environment. Introduction to smart contracts and its development environment. Introduction to blockchain applications in different domains like government, health and genomics.

References:

1. Melani Swan, Blockchain: Blueprint for a New Economy (1e), O'Reilly Media, 2015.
2. Paul Vigma, Michael J. Casey, The Truth Machine: The Blockchain and the Future of Everything (1e), St Martin's Press, 2018.
3. Daniel Drescher, Blockchain Basics: A Non-Technical Introduction in 25 Steps (1e), Apress, 2017.

ICT 5052 CYBER SECURITY [3 0 0 3]

Introduction to Information, Network and System Security, Encryption techniques, Message Integrity and Message Authentication, Digital Signature, Key Management, User Authentication. Web security model: Browser security model including same-origin policy, Client-server trust boundaries, Session management, authentication: Single sign-on, HTTPS and certificates. Application vulnerabilities and defenses: SQL injection, XSS, CSRF. Client-side security: Cookies security policy, HTTP security extensions, Plugins, extensions, and web apps, Web user tracking, Server-side security tools, e.g. Web Application Firewalls (WAFs) and fuzzers. Cybercrime, Cybercrime investigation, Laws and ethics.

References:

1. Mayank Bhushan, Fundamentals of cybersecurity, BPB publications, 2017
2. Raef Meeuwisse, Cyber Security for Beginners, 2015
3. Rolf Oppliger, Security Technologies for the World Wide Web (2e), Artech House, 2002.
4. Seth Fogie, Jeremiah Grossman, Robert Hansen and Anton Rager, XSS Attacks: Cross Site Scripting Exploits and Defense, Syngress, 2007.
5. Justin Clarke et.al.,SQL Injection Attacks and Defense (2e), Syngress, 2012.

ICT 5053 GAME THEORY AND APPLICATIONS [3 0 0 3]

Introduction, Mathematical Preliminaries, Non-Cooperative Game Theory: Extensive Form Games, Strategies Form Games, Dominant Strategy Equilibria, Nash Equilibria, Matrix Games, Bayesian Games, Cooperative Game Theory: Two Person Bargaining Problem, Coalition Games, Shapely Values, Mechanism Design: Social Choice Functions, Incentive Compatibility and Revelation Theorem, Auctions.

References:

1. Y Narahari, Game Theory and Mechanism Design, World Scientific, India, 2015
2. Tim Roughgarden, Twenty Lectures of Algorithmic Game Theory, Cambridge University Press, 2016
3. Dario Bauso, Game Theoy with Engineering Applications, SIAM, Philadelphia, 2016

ICT 5054 REAL TIME SYSTEMS [3 0 0 3]

Introduction to Real Time Systems, Resource management, Commonly used approaches for real time scheduling-static scheduling, priority driven scheduling, RM and DM algorithms, Aperiodic jobs and scheduling, Computation of average response time, Various servers: Deferrable, Sporadic etc. Bandwidth computation, Resource access protocols: various resources access protocols and features, Advantages and drawbacks, Priority ceiling protocols and its use in dynamic priority systems, multiprocessor scheduling, Task assignment and conditions, Faults and fault handling, Redundancy and handling redundancy, Real time communication.

References:

1. Jane W.S.Liu, Real Time Systems, Pearson Edition-2006.
2. Philip A Laplante, Real-Time Systems design and analysis (3e),Wiley interscience, 2004
3. Philip A Laplante and Seppo J Ovasaka , Real-Time Systems design and analysis; Tools for the practitioners (4e), IEEE press, 2012

DEPARTMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY, MIT Manipal

M.Tech. COMPUTER NETWORKING & ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5157	Probability and Stochastic Process	4	0	0	4	ICT 5271	Advanced Communication Network Technologies	4	0	2	5
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ICT 5272	Information Security	3	0	2	4
	ICT 5151	Advanced Data Structures and Algorithms	3	0	2	4	ICT ****	Elective I	3	0	2	4
	ICT 5171	Advanced Operating Systems	4	0	0	4	ICT ****	Elective II	3	0	2	4
	ICT 5172	Communication Network Protocols	4	0	2	5	ICT ****	Elective III	4	0	0	4
	ICT 5173	Mobile Computing	3	0	2	4	***.****	Open Elective	3	0	0	3
	ICT 5163	Advanced Operating Systems Lab	0	0	2	1	ICT 5261	Advanced Technology Lab	0	0	3	1
	ICT 5164	Software Engineering Lab	0	0	3	1						
		Total	**19**	**0**	**14**	**25**		**Total**	**20**	**0**	**11**	**25**
II	THIRD AND FOURTH SEMESTER											
	ICT 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
ICT 5001	Big Data Technologies	ICT 5008	Parallel Computation and Applications
ICT 5002	Cloud Computing	ICT 5010	Advanced Telecommunication Technologies
ICT 5003	Deep Learning	ICT 5011	Data Warehousing and Data Mining
ICT 5005	Information Retrieval	ICT 5012	Multimedia Communication
ICT 5007	Machine Learning		

OPEN ELECTIVES			
ICT 5051	Blockchain Technology and Applications	ICT 5053	Game Theory and Applications
ICT 5052	Cyber Security	ICT 5054	Real Time Systems

SEMESTER I

MAT 5157 PROBABILITIY AND STOCHASTIC PROCESS [4 0 0 4]

Random Variables, one and two dimensional random variables, probability density function, Expectation, variance covariance, correlation coefficient of random variables, uniform distributions, Functions of random variables, probability distributions of functions of random variables, conditional probability distributions of two dimensional random variables. Sampling, Estimation of mean and variance, Maximum likelihood estimate, interval estimation. Stochastic Process, Stationarity, Auto correlation, Markov models, Gaussian mixture models. Game Theory – two person zero sum game, various methods to solve zero sum games. Linear algebra – eigen values and eigen vectors, diagonalization, decomposition of matrices.

References:

1. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
2. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.
3. David C Lay, Linear Algebra and its Applications (3e), Pearson Publications
4. Hogg and Craig, Introduction to Mathematical Statistics, Mc. Millan company5. Hamdy A. Taha – Operations Research McGraw Hill..

ICT 5151 ADVANCED DATA STRUCTURES & ALGORITHMS [3 0 2 4]

Performance analysis of algorithms, Advanced data structures- Trees, Binary trees, Balanced trees, Hashing, Priority queues, Searching and sorting, The disjoint set ADT, Path compression algorithms, Algorithm design techniques-Greedy, divide and conquer, Backtracking, dynamic programming, Branch and bound, randomized algorithms, NP completeness, Introduction to Parallel algorithms.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in Java, Pearson Education 2012
2. Sahni, Data structures, Algorithms and Applications in Java (2e), Silicon Press, 2004.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein., Introduction to Algorithms (3e), PHI Learning Pvt. Ltd., Eastern Economy Edition, PHI, 2010
4. Vipin Kumar, Anshul Gupta, George Karpis Ananth Grama, Introduction to Parallel Computing (2e), Pearson Education Limited, 2003.

ICT 5171 ADVANCED OPERATING SYSTEMS [4 0 0 4]

Review of the basic operating system concepts, distributed operating system architecture, issues and communication mechanisms, logical clocks, vector clocks, mutual exclusion and deadlock detection in distributed environment, distributed file systems and shared memory concepts, failure recovery and fault tolerance concepts, resource security and protection, scheduling algorithms in real time operating system, database and multiprocessor system concepts.

References:

1. M. Singhal and N.G. Shivaratri, Advanced concepts in operating systems, TMH (1e), 2017.
2. A. S. Tanenbaum, Modern Operating Systems, PEI (4e), 2016.
3. L. Jane W. S., Real time systems, Pearson LPE, 2018

ICT 5172 COMMUNICATION NETWORK PROTOCOLS [4 0 2 5]

Introduction, Connectionless and connection-oriented service, circuit and packet switching, packet forwarding in computer networks, network access and physical media, ISPs and Internet backbones, delay and loss in packet-switched networks, protocol layers and their service models. Queuing Models, LANs, Network service models, routing principles, hierarchical routing, the Internet Protocol (IP), Routing in the internet, Multicasting and Multicast Routing, Introduction to transport layer services, TCP, UDP and SCTP, Principles of congestion control, TCP Congestion control, Client–Server Model, Socket programming with TCP, socket programming with UDP

References:

1. Behrouz A. Forouzan, TCP/IP Protocol Suite (3e), Tata McGraw Hill, 2012.
2. Leon-Garcia and Widjaja, Communication Networks, Tata McGraw Hill, 2010.
3. Jean Walrand and Pravin Varayya, High Performance Communication Networks, Harcourt Asia Pvt Ltd., 2010.
4. Andrew S. Tanenbaum, Computer Networks (4e), Prentice Hall India, 2012.
5. Richard W Stevens, Unix Network Programming, Vol. – I, Pearson Education 2004.

ICT 5173 MOBILE COMPUTING [3 0 2 4]

Mobile computing models, Wireless location services, Mobile agents, 6LoWPAN Architecture, Cognitive radio architecture, Spectrum sensing and management, WiMAX architecture and its evaolution, OFDM frequency selective channels, Multiple access OFDMA, WCDMA/UMTS channels, Channel coding, Spreading and modulation, LTE.

References:

1. Jiannong Cao, Sajal K. Das, Mobile Agents in Networking and Distributed Computing (1e), Wiley-Interscience, July 2012.
2. Zach Shelby, Carsten Bormann, 6LoWPAN: The Wireless Embedded Internet, John Wiley Publications, 2011.
3. Andrea Molisch, Wireless Communications (2e), Wiley Publications, 2012.
4. Frank Adelstein, Sandeep K.S. Gupta, Golden Richard, Loren S, Fundamentals of Mobile and Pervasive Computing (1e), Mc-Graw Hill Companies, 2005.
5. Saad Z. Asif, Next Generation Mobile Communications Ecosystem: Technology Management for Mobile Communications, Wiley Publications, 2011.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION HUM [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

ICT 5163 ADVANCED OPERATING SYSTEMS LAB [0 0 2 1]

The advanced operating systems lab deals with the implementation of various algorithms related to the topics such as process synchronization (producer-consumer), deadlock detection, remote method invocation, Lamport's logical clock, token based and non-token based mutual exclusion algorithms.

ICT 5164 SOFTWARE ENGINEERING LAB [0 0 3 1]

The Software Engineering Lab deals with requirement analysis, design and implementation of a software problem. The students will be learning various Unified Modeling Language (UML) diagrams to design a software system and also would be modeling them using the IBM Rational Software Architect tool. The students will also develop a working software using all the software development life cycle activities which they will be learning in the course.

SEMESTER II

ICT 5271 ADVANCED COMMUNICATON NETWORK TECHNOLOGIES [4 0 2 5]

Adhoc Networks, Inter-vehicular communications and GPS, Switch performance measures, Time and space switches, Modular switch design Packet switch and distributed Buffer Optical N/W, DWDM, High-speed Networks, Circuits switched N/W: SONET and SDH. IP forwarding Architectures, RSVP ,ATM, MPLS, Network Management: Organization and Information Models, Communication and functional models, SNMPv2, SDN Background and Motivation, SDN Data Plane, SDN Control Plane, Controllers, OpenFlow: OpenFlow Logical Network Device -Flow Table Structure , Flow Table Pipeline, The Use of Multiple Tables , Group Table, OpenFlow Protocol, Program a SDN enabled switch as hub, learning switch Software Defined Networks.

References:

1. Mani Subramanian, Timothy A. Gonsalves, N Usha Rani, Network Management, Principles and Practice (2e), Pearson Education India, 2010.
2. Jean Walrand and Praveen Varaiya, High-Performance Communication NetWorks (2e), Morgan Kaufmann 2000.
3. Leon-Garcia and Widjaja, Communication Networks (2e), Tata McGraw-Hill, 2010.
4. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud (1e), Addison-Wesley Professional, 2015.
5. Siamak Azodolmolky, Software Defined Networking with OpenFlow, Packt publishing, 2013.

ICT 5272 INFORMATION SECURITY [3 0 2 4]

Network security principles, types of attacks, cryptography, mathematics of cryptography, private key and public key cryptography, operating system security, protected objects and methods of protection, File protection mechanisms, database security, reliability and integrity, sensitive data, multilevel database, security in networks, IPSec, email security, SSL/TLS, Web security, SET protocol, Intruder Detection Systems, Public Key Infrastructure, X.509, digital certificates, trust models, Blockchain technology.

References:

1. Stallings W., Cryptography and Network Security: Principles and Practice (7e), Pearson Publications, 2016.

Pfleeger

2. C. P., Pfleeger S.L., Margulies J., Security in Computing (5e), Prentice Hall, 2015
3. Matt Bishop, Computer Security: Art and Science, Pearson Education, 2003.
4. Ronald D. Krutz, Russel Dean Vines, Cloud Security: A Comprehensive guide to secure cloud computing, Wiley India editions, 2010
5. Kaufman, Perlman, Speciner, Network Security (2e), Prentice Hall, 2003

ICT 5262 ADVANCED TECHNOLOGY LAB [0 0 3 1]

The lab has been designed to have 2 components:

I. Hands on using a programming language (python)

ii. Design and implementation of a solution for a selected problem statement (a mini project)

Lab exercises focus on basics of python programming, lists, tuples, sets, dictionaries, control flows, functions, modules, regular expressions, object oriented programming, network, web and database programming, plots, image processing, machine learning, carrying out.

Mini project: Design and implementation of mini project

SEMESTER III & IV

ICT 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

ICT 5001 BIG DATA TECHNOLOGIES [3 0 2 4]

Overview of Big data, Data Analysis, Hadoop, HDFS, Data ingestion using Fume and Scoop, MapReduce structure, Writing MapReduce programs, Hadoop Ecosystem: Pig, Hive, Working with Spark, Stream Data analytics: models, queries, NOSQL: properties, models, querying, Case Studies for big data analytics.

References:

1. Tom White, Hadoop: The definitive guide (3e), O'reilly, Yahoo Press, 2012.
2. Nataraj Dasgupta, Practical Big Data Analytics (1e), Packt publishing Ltd, 2018
3. Shashank Tiwari,Professional NOSQL(1e),Wiley India Pvt.Ltd., 2012
4. Bill Chambers and Matei Zaharia,Spark:The Definitive Guide (1e), Shroff/O'Reilly, 2018

ICT 5002 CLOUD COMPUTING [3 0 2 4]

Introduction to Cloud Computing, Challenges of cloud computing, Understanding Cloud Architecture and Services, Application Paradigms, Virtualization, Compute Virtualization, Storage Virtualization, Network Virtualization, Cloud Resource Management and Scheduling, Cloud Security, Cloud Application Development.

References:

1. Sehgal, Naresh Kumar, and Pramod Chandra P. Bhatt, Cloud Computing: Concepts and Practices, Springer, 2018.
2. Dan C Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, 2013.
3. Naveen Sabharwal and Ravi Shankar, Apache CloudStack Cloud Computing, Packt Publishing Ltd., 2013.
4. Mark C Chu-Carroll, Code in the Cloud, Pragmatic Bookshelf, 2011.
5. Barrie Sosinsky, Cloud Computing Bible, Wiley Publishing Inc., 2011.

ICT 5003 DEEP LEARNING [3 0 2 4]

Introduction, Mathematical Preliminaries, Machine Learning Basics, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Recurrent and Recursive Networks, Practical Methodology

References:

1 Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press 2016
2 Simon Haykin, Neural Networks & Learning Machines, Pearson, 2018
3 Charu C Agarwal, Neural Networks & Deep Learning, Springer 2018
4 Andrew Ng's Notes on Machine Learning from CS229

ICT 5005 INFORMATION RETRIEVAL [4 0 0 4]

Boolean Retrieval, Term Vocabulary and Postings Lists, Dictionaries and Tolerant Retrieval, Index Construction and Index Compression, Scoring, Term Weighting and Vector Space Model, Computing Scores in a Complete Search Systems, Evaluation in Information Retrieval, Relevance Feedback and Query Expansion, Matrix Decomposition and Latent Semantic Index, Web Search Basics, Web crawling and indexes, Probabilistic Information Retrieval, Multimedia Information Retrieval.

References:

1. Christopher D. Manning, PrabhakarRaghavan and HinrichSchutze, Introduction to Information Retrieval (1e), Cambridge University Press, 2008.
2. Morgan and Claypool, Multimedia Information Retrieval, 2010.
3. David A Grossman and OphirFrieder, Information Retrieval: Algorithms and Heuristics (2e), Springer, 2004
4. Ian H Witten, Alistair Moffat and Timothy C.Bell, Managing Gigabytes: Compressing and Indexing Documents and Images (2e), Morgan Kaufmann, 1999
5. Amy N Langville and Carl D Meyer, Google's Page Rank and Beyond: The Science of Search Engine Ranking (1e), Princeton University Press, 2006

ICT 5007 MACHINE LEARNING [3 0 2 4]

Introduction to Machine Learning, Mathematical Preliminaries, Supervised Learning: Logistic Regression, Generative Learning Algorithms, GDA, SVM, Model Selection, Ensemble Methods, Learning Theory: Bias/Variance tradeoff, Union, Chernoff and Hoeffding bounds, VC dimension, Unsupervised Learning: K-means, EM, GMM, Factor Analysis, PCA, ICA, Reinforcement Learning and Control: MDPs, Bellman Equation, LQR, LQG, and Q-learning.

References:

1. Kevin P Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012.
3. Christopher M.Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
4. Andrew Ng, CS229 Machine Learning, Autumn 2018, Stanford University

ICT 5008 PARALLEL COMPUTATION AND APPLICATIONS [3 0 2 4]

CPU and GPU architectures for parallel computation, Data parallelism and CUDA C, Data parallel execution model, CUDA memories, CUDA resource constraints and their impact on kernel execution performance, Parallel patterns, CUDA prepackaged libraries, Applications, More on CUDA and graphics processing unit computing, An introduction to OpenCL for CUDA programmers.

References:

1. David B. Kirk and Wen mei W. Hwu, Programming Massively Parallel processors A Hands on Approach (3e), Morgan Kaufman, 2016.
2. Tolga Soyata, “GPU Parallel Program Development Using CUDA”, CRC Press, 2018.
3. Bhaumik Vaidya, Hands-On GPU-Accelerated Computer Vision with OpenCV and CUDA: Effective techniques for processing complex image data in real time using GPUs (1e), Packt Publishing, 2018.
4. John Cheng, Max Grossman, and Ty McKercher, Professional CUDA C Programming, John Wiley & Sons, Inc.2014.
5. Shane Cook, CUDA Programming: A developer's guide to parallel computing with GPUs (1e), Morgan Kaufman, 2013.

ICT 5010 ADVANCED TELECOMMUNICATION TECHNOLOGIES [4 0 0 4]

The Evolution from UMTS to Long Term Evolution, LTE Architecture, performance evaluation of 4G, multi-antenna transmission, IP multimedia subsystem, Circuit switched fallback, Voice over IP, massive MIMO techniques, power control principles, 5G architecture, quality of service, small cells, white spaces and virtualization support.

References:

1. Stefania Sesia, Matthew Baker, Issam Toufik, LTE - The UMTS Long Term Evolution: From Theory to Practice (2e), Wiley Publications, 2011
2. Christopher Cox, An introduction to LTE – LTE, LTE-Advanced, SAE, and 4G mobile communications (1e), John Wiley & Sons, 2012.
3. Thomas L. Marzetta, Erik G. Larsson, Hong, Fundamentals of Massive MIMO (1e), Cambridge University Press, 2016.
4. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks (1e), Wiley Publications, 2015

ICT 5011 DATA WAREHOUSING AND DATAMINING [3 0 2 4]

Introduction to Relational Database Design, SQL, Introduction to Data Warehousing, Multi-dimensional data model, OLAP operations, Warehouse schema, Data Warehousing Architecture, Warehouse server, Metadata, OLAP Engine, Data Warehouse Backend Process. Data Preprocessing, Data cleaning, Data Integration and transformation, Data reduction, Data cube, Dimensionality reduction, Sampling, Discretization and concept hierarchy generation, Segmentation by natural partitioning. Introduction to Data mining, Association rules mining, market based analysis, Apriori Algorithm, Partition Algorithm, Pincer – Search Algorithm, Dynamic item set counting algorithm, FP-tree growth Algorithm,PC Tree, Multilevel association rules, Approaches to mining multilevel association rules, correlation analysis, Issues and challenges in Data mining. Introduction to Clustering Techniques, Partitioning Algorithms, k – Medoid& k- means Algorithms, CLARA, CLARANS, Hierarchical Clustering, DBSCAN. Introduction to Classification and Prediction, Tree Construction principle, Best Split, Splitting Indices, Splitting Criteria, Decision Tree Construction Algorithm, Tree pruning.

References:

1. Jiawei Han and MichelineKamber, Data Mining Concepts And Techniques (2e), Morgan Kauffmann Publishers, 2008
2. Arun K Pujari, Data Mining Techniques (1e), Universities Press India, 2001.
3. Silberschatz, Korth and Sudarshan, Database System Concepts (6e), McGraw Hill, 2010

ICT 5012 MULTIMEDIA COMMUNICATION [3 0 2 4]

Introduction to multimedia, properties of sound, image & video. Topics in data compression including coding requirements, JPEG, MPEG etc., Multimedia Operating system, Process Management, QoS protocols. Multimedia Systems, video handling, time based modeling methods.

References:

1. Ralf Steinmetz and KlaraNahrstedt, Multimedia: Computing, Communications and Applications, Prentice Hall PTR, 2012.
2. Ze-Nian Li, and Mark S. Drew, Fundamentals of Multimedia (2e), Pearson Prentice Hall, 2014.
3. K. R. Rao, Z. S. Bolzkovic, D. A. Milanovic, Multimedia Communication Systems (2e), Prentice Hall, May 2009.
4. Stephen McGloughlin, Multimedia: Concepts and Practice, Prentice Hall, 2001.
5. Rafael C Gonzalez; Richard E Woods, Digital Image Processing, Pearson, New York, 201

OPEN ELECTIVES

ICT 5051 BLOCKCHAIN TECHNOLOGY & APPLICATIONS [3 0 0 3]

Introduction to technology stack: Blockchain, protocol, understanding how blockchain works. Introduction to consensus model. Architecture of decentralized application, Dapps development process and command, application model for Dapp, introduction to Dapp development environment. Introduction to smart contracts and its development environment. Introduction to blockchain applications in different domains like government, health and genomics

References:

1. Melani Swan, Blockchain: Blueprint for a New Economy (1e), O'Reilly Media, 2015.
2. Paul Vigma, Michael J. Casey, The Truth Machine: The Blockchain and the Future of Everything (1e), St Martin's Press, 2018.
3. Daniel Drescher, Blockchain Basics: A Non-Technical Introduction in 25 Steps (1e), Apress, 2017.

ICT 5052 CYBER SECURITY [3 0 0 3]

Introduction to Information, Network and System Security, Encryption techniques, Message Integrity and Message Authentication, Digital Signature, Key Management, User Authentication. Web security model: Browser security model including same-origin policy, Client-server trust boundaries, Session management, authentication: Single sign-on, HTTPS and certificates. Application vulnerabilities and defenses: SQL injection, XSS, CSRF. Client-side security: Cookies security policy, HTTP security extensions, Plugins, extensions, and web apps, Web user tracking, Server-side security tools, e.g. Web Application Firewalls (WAFs) and fuzzers. Cybercrime, Cybercrime investigation, Laws and ethics

References:

1. Mayank Bhushan, Fundamentals of cybersecurity, BPB publications, 2017
2. Raef Meeuwisse, Cyber Security for Beginners, 2015
3. Rolf Oppliger, Security Technologies for the World Wide Web (2e), Artech House, 2002.
4. Seth Fogie, Jeremiah Grossman, Robert Hansen and Anton Rager, XSS Attacks: Cross Site Scripting Exploits and Defense, Syngress, 2007.
5. Justin Clarke et.al.,SQL Injection Attacks and Defense (2e), Syngress, 2012.

ICT 5053 GAME THEORY AND APPLICATIONS [3 0 0 3]

Introduction, Mathematical Preliminaries, Non-Cooperative Game Theory: Extensive Form Games, Strategies Form Games, Dominant Strategy Equilibria, Nash Equilibria, Matrix Games, Bayesian Games, Cooperative Game Theory: Two Person Bargaining Problem, Coalition Games, Shapely Values, Mechanism Design: Social Choice Functions, Incentive Compatibility and Revelation Theorem, Auctions.

References:

1. Y Narahari, Game Theory and Mechanism Design, World Scientific, India, 2015
2. Tim Roughgarden, Twenty Lectures of Algorithmic Game Theory, Cambridge University Press, 2016
3. Dario Bauso, Game Theoy with Engineering Applications, SIAM, Philadelphia, 2016

ICT 5054 REAL TIME SYSTEMS [3 0 0 3]

Introduction to Real Time Systems, Resource management, Commonly used approaches for real time scheduling-static scheduling, priority driven scheduling, RM and DM algorithms, Aperiodic jobs and scheduling, Computation of average response time, Various servers: Deferrable, Sporadic etc. Bandwidth computation, Resource access protocols: various resources access protocols and features, Advantages and drawbacks, Priority ceiling protocols and its use in dynamic priority systems, multiprocessor scheduling, Task assignment and conditions, Faults and fault handling, Redundancy and handling redundancy, Real time communication.

References:

1. Jane W.S.Liu, Real Time Systems, Pearson Edition-2006.
2. Philip A Laplante, Real-Time Systems design and analysis (3e),Wiley interscience, 2004
3. Philip A Laplante and Seppo J Ovasaka , Real-Time Systems design and analysis; Tools for the practitioners (4e), IEEE press, 2012

Department of Instrumentation & Control Engineering

The Department of Instrumentation and Control Engineering was established in the year 2001, with a B.Tech course in Instrumentation & Control Engineering. Since 2018, the department is offering B.Tech in Electronics and Instrumentation Engineering in place of Instrumentation and Control Engineering. The course deals with Electronics, Control system and Instrumentation subjects. The department has state-of-the-art laboratories in the areas of Instrumentation, Process Control, Control Systems, Microcontrollers, Soft Computing, Industrial Automation and Space Engineering Lab. All the department programs are AICTE approved.

The Department has expertise available in the field of Sensors, Robust Control, Neural Network and Fuzzy Logic, Bio-medical Instrumentation, Digital Signal Processing, Image Processing, Adaptive Control, MEMS, Electronic Instrumentation, Embedded Systems, Hybrid Systems, Automation etc. The Department is involved in numerous active research works in the above emerging fields. The department also organizes various research workshops and conferences. Control Instrumentation System Conference (CISCON) is an annual event organized under the auspices of Instrumentation and Control Engineering Department.

Programs offered

Under Graduate Program

- B.Tech in Electronics and Instrumentation Engineering (2018)

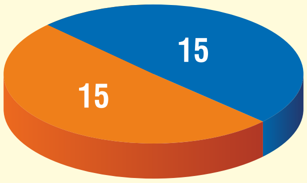
Post Graduate Programs

- M.Tech in Control Systems (2005)
- M.Tech in Aerospace Engineering (2007)

PhD

Faculty Strength

Qualification-wise



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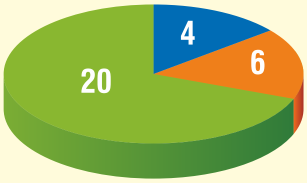


DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING, MIT Manipal

M.Tech. CONTROL SYSTEMS

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5156	Applied Linear Algebra and Probability	4	0	0	4	ICE 5251	Analysis of Nonlinear Systems	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ICE 5252	System Identification	4	0	0	4
	ICE 5151	Adaptive Control	4	0	0	4	ICE ****	Elective I	4	0	0	4
	ICE 5152	Advanced Control Theory	3	1	0	4	ICE ****	Elective II	4	0	0	4
	ICE 5153	Navigation, Guidance and Control	4	0	0	4	ICE ****	Elective III	4	0	0	4
	ICE 5154	Process Dynamics and Control	4	0	0	4	ICE ****	Open Elective	3	0	0	3
	ICE 5161	Control System Design Lab	0	0	3	1	ICE 5261	Advanced Process Control Lab	0	0	3	1
	ICE 5162	Process Dynamics Lab	0	0	3	1	ICE 5265	System Identification Lab	0	0	3	1
	ICE 5163	System Modeling and Simulation Lab	0	0	3	1						
		Total	**20**	**1**	**12**	**25**		**Total**	**23**	**0**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	ICE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
ICE 5001	Advanced Sensor Technology	ICE 5006	Industrial Automation
ICE 5002	Artificial Intelligence	ICE 5007	Optimal Control
ICE 5003	Computer Networks	ICE 5008	Robotics and Automation
ICE 5004	Embedded Control Systems	ICE 5009	Robust and H_∞ -Control
ICE 5005	Hybrid Dynamical Systems		

OPEN ELECTIVES			
ICE 5052	Robust Control	ICE 5053	Virtual Instrumentation

SEMESTER I

MAT 5156 APPLIED LINEAR ALGEBRA AND PROBABILITY [4 0 0 4]

Finite dimensional vector space, subspaces, linear independence, bases and dimension, Algebra of transformations, range and null space of a linear transformation, matrix algebra, simultaneous equations. Sum and intersection of subspaces, direct sum of invariant subspaces, eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Sylvester's interpolation method, various canonical form. Algebra of polynomial matrices, invariant. Polynomial matrices, invariant polynomials, Smith canonical form. Inner-product spaces, Gram Schmidt orthogonalization, decomposition, Some computational methods of linear algebra., Probability theory: Review of Set theory; introduction to probability, axioms of probability; joint and conditional probability; Bayes theorem.

Reference:

1. P. L. Meyer, Introductory to probability and Statistical Applications. Addison-Wesley Publishing Company, 1970.
2. Finkbeiner D.T. I, Introduction to Matrices and linear Transformation, D.B. Taraorewala's 1968.
3. Hoffman, K and Kunze, R, Linear Algebra, Prentice Hall of India 1972.
4. Gantmocher F.R., The Theory of Matrices, Cheisea, 1960.
5. Goult, R.J., Hoskin, R.P., Milner, J.A and Pratt, M.J, Computational methods in Linear Algebra, Stanley Thomas Pub. Ltd., 1974.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology, Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation, Criteria of a good research problem. Characteristics and Types of hypothesis, Procedure for hypothesis testing., Introduction to various sampling methods and their applications. Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis, Writing thesis, Writing journal and conference papers, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

Reference:

1. Dr. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W.Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004.
4. Suresh C.Sinha and Anil K.Dhiman, Research Methodology (2Vols-Set), Vedam Books, 2006.
5. C.R.Kothari, Research Methodology; Methods and Techniques, New Age International Publisher, 2008.

ICE 5151 ADAPTIVE CONTROL [4 0 0 4]

Mathematical models of systems, discretization techniques, computer solution of differential equations, simulation of process dynamics, state models, Conventional techniques of identification, identifications of systems with dead time, discrete systems, ARMA process, discrete state model, least squares techniques, Adaptive Control of Deterministic Systems, adaptive control algorithms for closed loop pole assignment, adaptive control of time varying systems, state estimation and observers, Parameter estimation and state estimation, Luenberger asymptotic observers, adaptive predictive control systems.

Reference:

1. Astrom K.J., and Wittenamrk B, Adaptive control, Addison Wesley Publishing Co.1989
2. Sastry S. and Bodson M., Adaptive control Stability, Convergence and Robustness, Prentice Hall, 1989
3. Hsia T.C.H.A. System identification, Lexington Books. 1974
4. Milon W.T., Sutton R.S., and Webros P J- Neural networks for control, MIT press, 1992
5. Stephanopoulis G, Chemical Process Control, Prentice Hall of India,1990

ICE 5152 ADVANCED CONTROL THEORY [3 1 0 4]

Compensator design using Root Locus and Bode plot, Continuous time PID controller design. Discrete time control, Sample and hold, Difference equation, pulse transfer function, Block diagram reduction, signal flow graph, steady state errors, stability, Jury's test, Root locus and Bode plot of Discrete time systems, Discrete PID controllers, State variable analysis of continuous time and discrete time systems, State variable representation, transfer function, stability, eigen values, eigen vectors, Transformation to Canonical forms, Minimal realization, State transition matrix, Conversion of continuous to discrete time systems, solution of state equations, Controllability, observability, state feedback, pole placement, Ackerman's formula, Observers.

Reference:

1. K. Ogata, Discrete time control Systems, second edition, 2e, PHI, 2005
2. M Gopal, Digital Control and State Variable methods, third edition Tata McGraw-hill, 2008
3. Les Fenical, Control Systems, Cengage Learning, India Edition, 2007
4. K Ogata, Modern Control Engineering, 5e, PHI, 2011
5. V I George, C P Kurian, Digital control Systems, Cengage Learning, 2012.

ICE 5153 NAVIGATION, GUIDANCE AND CONTROL [4 0 0 4]

Longitudinal dynamics, displacement autopilot, glide slope control system. Lateral dynamics of an Aircraft, Yaw orientation control system, Roll angle control system, Landing, Missiles- Missile Control Systems; Dynamics and Control of Rigid and Elastic Rockets; Control-Structure Interaction, Autopilots for Rigid Aircraft, Terrestrial navigation, Celestial navigation, Terrestrial radio navigation, satellite-based navigation, inertial navigation, Integrated Navigation, Command and Homing Guidance Systems, Mission consideration and analysis of flight path, Optimal guidance Laws, Inertial Guidance, design of Controllers for Aerospace Vehicles, Classical, Pole assignment, Eigen Structure Assignment, Optimal Control, LQR, LQG/LTR, Observers and Kalman Filters.

Reference:

1. Garnell, P, Guided Weapon Control Systems, Peraganon. 1980.
2. Blakelock, J H. Automatic Control of Aircraft and Missiles, John Wiley. 1991
3. Skolnik R E. Introduction to Radar System, Mc Graw Hill. 1982
4. Lin, C F. Modern Guidance, Navigation and Control Processing, Prentice-Hall.1991
5. B. Hofmann-Wellenhof, K. Legat, M. Wieser, Navigation Principles of Positioning and Guidance. Springer Wien New York, 2003.

ICE 5154 PROCESS DYNAMICS AND CONTROL [4 0 0 4]

Process control principles, servomechanism, identification of elements, Dynamics of various process, Batch process and continuous process, Classification of variables, design elements of a control system, control aspects of a process. Modes of operation of P, PI and PID controllers, Pneumatic and electronic controllers, I/P and P/I converters, Pneumatic and electric actuators, control valve, Stability considerations, performance criteria, type of feedback controller, feed forward control, Ratio Control, Cascade Control, Override control, auctioneering control, split range control, Processes with large dead time, Control of systems with inverse response, Plant wide control issues. Model Predictive Control.

Reference:

1. Curtis Johnson,Process Control Instrumentation Technology, Prentice Hall of India. 1996.
2. George Stephanopoulos, Chemical Process Control, Prentice Hall of India. 2005.
3. Caughanour and Koppel, Process systems analysis and control, Tata McGraw Hill, 1991.
4. Dale E. Seborg, Process Dynamics and Control, John Wiley, 2009.
5. Liuping Wang, Model Predictive Control System Design and Implementation Using MATLAB, Springer, 2009.

ICE 5161 CONTROL SYSTEM DESIGN LAB [0 0 3 1]

Block diagram reduction, Time domain and Frequency domain analysis, Stability analysis, Compensator design using Root locus and Bode plot, Pole Placement, DC Motor control, PID controller Characteristics, Compensator design in hardware, Temperature control.

Reference:

1. K Ogata, Modern Control Engineering 5 edition, Pearson education, 2011
2. M Gopal, Digital Control and State Variable methods, 3 edition Tata McGraw-hill, 2008
3. Les Fenical, Control Systems, Cengage Learning, India Edition, 2007
4. C.T. Chen Analog and Digital control System Design, Oxford University Press,2006.

ICE 5162 PROCESS DYNAMICS LAB [0 0 3 1]

Study the characteristics of P, PI, PID Controller modes of Level Control System, Flow Control System, Temperature Control System, Pressure Loop, Study of Cascade System,PID Controller modes in Ratio control, Feed forward control for various Feed forward factor, PLC and the implementation of Logics, Control of Bottle filling Plant using PLC, PLC programming for the Traffic Light Control, Internal Model Control, Digital PID Controller, Split Range control in LabVIEW, State feedback controller for the Inverted Pendulum, Study of DCS and SCADA, Real Time Data Acquisition

Reference:

1. Curtis D. Johnson, *Microprocessors in Process Control*, PHI. 1993
2. George Stephanopoulos *Chemical Process Control.* 2005
3. Coughner *Process Analysis & Control*, Tata Mcgraw Hill. – 1991

ICE 5163 SYSTEM MODELING AND SIMULATION LAB[0 0 3 1]

Modeling, Simulation and control implementation for Ball and Beam Systems, Modeling, Simulation and control implementation for Magnetic Levitation system, Modeling, Simulation and control implementation for Twin Rotor MIMO system, Modeling, Simulation and control implementation for 3DOF Helicopter System.

Reference:

1. Technical Manual for Ball and Beam System, Maglev system, Twin Rotor MIMO system, 3DOF helicopter System and dSpace Control software provided by the respective company manual.
2. R C. Dorf and R H. Bishop, Modern Control Systems, 12th Edition, Pearson Publication, 2014
3. John. D. Anderson, Introduction to Flight, 6th Edition, McGraw Hill Education, 2010
4. G.D Padfield, Helicopter flight dynamics, 2nd Edition, Blackwell Publishing, 2007

SEMESTER II

ICE 5251 ANALYSIS OF NONLINEAR SYSTEMS [4 0 0 4]

Nonlinear system behaviour, phase plane, singular points, limit cycles, stability, describing function, stability of sustained oscillations, Lyapunov theory, positive definite functions and lyapunov functions, Lyapunov's direct method, Lyapunov analysis of linear time invariant systems, stability analysis of non linear systems, Krasovskii's method, the variable gradient method, performance analysis, control design based on lyapunov's direct method, Lyapunov analysis of non-autonomous systems, Graphical Linearization Methods, Analytical Linearization Method, Feedback linearization and the canonical form, Input – state linearization, input – output linearization, Sliding**,** modeling performance trade-offs, Control of multi input physical systems, adaptive robot trajectory control, spacecraft control, attitude control.

Reference:

1. R. Marino and P. Tomei Nonlinear control design - Geometric, Adaptive and Robust, Prentice Hall,1995
2. J.J.E.Slotine and W.Li Applied Nonlinear control, Prentice Hall, 1998
3. Alberto Isidori Non linear Control systems, Springer Verlag, , 1999
4. Dr. K. P Mohandas, Modern Control Engineering, Sanguine Publishers, 2006.
5. Modern Control Engineering, K. Ogata, PHI Pvt Limited, 1989

ICE 5252 SYSTEM IDENTIFICATION [4 0 0 4]

Classification of inputs and system models, coupling of subsystems, linearization, Analytical and experimental methods of modelling, Response to random inputs, state-space models, pseudo-random signal testing parameter tracking, regression and least-square methods, FIR and ARX models, development of ARX models by least square estimation, unmeasured disturbance modeling, system identification procedure, Non-parametric time and frequency domain methods, parameter estimation method, convergence and consistency, computing the estimate, recursive estimation methods.

Reference:
1. E.O. Doeblin, System Modelling and Response, John Wiley Sons, 1980
2. Desai and Lalwani, Identification Techniques, Tata McGraw Hill, 1977
3. L. Ljung, System Identification: Theory for the User, Prentice Hall, 1992
4. Philip D. Cha, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge, 2000.

ICE 5261 ADVANCED PROCESS CONTROL LAB [0 0 3 1]

Study of Heat Exchanger process and design of PID controller for the process. Non-Linear controller design for conical tank process. PID controller design for Continuous Stirred Tank Reactor (CSTR). Study of Spherical Tank process and PID controller design. Advanced controller design for Three-Tank process. Cascade loop design for pressure and temperature. Advanced controller design for process like Distillation Column, CSTR & Heat Exchanger. Interfacing process stations with DCS.

Reference:
1. Curtis D. Johnson, *Microprocessors in Process Control*, PHI. 1993
2. George Stephanopoulos *Chemical Process Control.* 2005
3. Coughner *Process Analysis & Control*, Tata Mcgraw Hill, 1991
4. Garry Dunning, Introduction to Programmable Logic Controllers, Thomson Learning, 2001
5. Popovik, Bhatkar, Distributed computer control for industrial automation, Marcel and Dekkar Pub, 1990

ICE 5265 SYSTEM IDENTIFICATION LAB [0 0 3 1]

Vector manipulation, Generating data set with random errors, least square curve fitting, transient response analysis, Linear regression, First order and second order model estimation, Correlation analysis, ARX model identification, Pseudo Random Binary Sequences generation and model estimation, Prediction error methods, Instrumental variable methods, Recursive identification, Closed loop identification and model validation, Frequency domain identification techniques.

Reference:
1. E.O. Doeblin, System Modelling and Response, John Wiley Sons, 1980
2. Desai and Lalwani, Identification Techniques, Tata McGraw Hill, 1977
3. L. Ljung, System Identification: Theory for the User, Prentice Hall, 1992
4. Philip D. Cha, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge, 2000.

SEMESTER III & IV

ICE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

ICE 5001 ADVANCED SENSOR TECHNOLOGY [4 0 0 4]

Advanced sensing techniques, Sensor classifications, advanced sensing materials, Optical Sensors: Fiber optic light propagation, Graded index fibers, Fiber optic communication driver circuits, Laser classifications, Driver circuits MEMS sensor, Fabrication and packaging issues, Thick film and thin film technique. Physical sensors: Hall Effect sensors, Eddy current sensors, magneto resistive and magnetostrictive detector. Aerospace Sensor: Accelerometers: Thermal, Humidity and moisture sensor Proximity detectors using polarized light, Semiconductor gas sensor. Fluidic and Micro-fluidic sensors, Gyroscope laser. Chemical sensor: Chemical sensor characteristics, Classification of Chemical sensing mechanism, potentiometric sensors, conductive sensors, amperometric sensors, enhanced catalytic gas sensors, engyme sensors. Lab on chip/senor platform technology. The role of PCA, LDA, Neural network in designing sensor array.

Reference:
1. Sabaree Soloman, Sensors Hand Book, McGraw Hill, 1998
2. Culshaw B and Dakin J (Eds) Optical Fibre Sensors, Vol. 1 & 2 Artech House, Norwood, 1989.
3. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 2010.
4. P Ripka, A Tipek, Modern Sensors Handbook. Wiley Publication, 2007.
5. Julian W Gardner, Vijay K Varadan, Microsensors, MEMS and Smart Devices, John Wiley & Sons, Inc. New York, 2001.

ICE 5002 ARTIFICIAL INTELLIGENCE [4 0 0 4]

Introduction, Agents and rationality, task environments, agent architecture types-Search and Knowledge representation-Search spaces-Uninformed and informed search- Hill climbing, simulated annealing, genetic algorithms - Logic based representations (PL, FoL) and inference, Prolog- Rule based representations, forward and backward chaining, matching algorithms- Probabilistic reasoning and uncertainty- Bayes nets and reasoning with them - Uncertainty and methods to handle it – Learning - Forms of learning - Statistical methods: naive-Bayes, nearest neighbour, kernel, neural network models, noise and overfitting - Decision trees, inductive learning - Clustering - basic agglomerative, divisive algorithms based on similarity/dissimilarity measures - Applications to NLP, vision, robotics.

Reference:
1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3e), Pearson, 2012
2. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence (3e), Tata McGraw Hill, 2012 3.
3. David Poole and Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents (2e), Cambridge University Press, 2017.
4. Nils Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann, 1998.

ICE 5003 COMPUTER NETWORKS [4 0 0 4]

Data Communications, Components, Direction of Data flow, Networks, Types of Connections, Protocols and Standards, Transmission Media, Line Coding RS232 Interfacing sequences. Data Link Layer : Error – detection and correction – Parity – LRC – CRC – Hamming code low Control and Error control - stop and wait – go back-N ARQ – selective repeat ARQ- sliding window – HDLC - LAN - Ethernet– FDDI - SONET – Bridges. Network Layer: Internetworks – Packet Switching and Datagram approach – IP addressing methods, Subnetting – Routing, Routers. Transport Layer: Duties of transport layer, Sockets – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control – Quality of services (QOS) – Integrated Services. Application Layer: Domain Name Space (DNS) Security Cryptography.

Reference :

1. Behrouz A. Forouzan, Data communication and Networking, Tata McGraw-Hill, 2004.
2. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Pearson Education, 2003.
3. Larry L.Peterson and Bruce S. Davie, Computer Networks, 5e, Morgan Kaufmann, 2011
4. Andrew S. Tanenbaum, Computer Networks, fourth edition, PHI, 2003.
5. William Stallings, Data and Computer Communication, sixth edition, Pearson Education, 2000.

ICE 5004 EMBEDDED CONTROL SYSTEM [4 0 0 4]

Introduction to Embedded world, Architecture and system Model, Introduction to ARM Microcontrollers. Serial Communications, SPI-Serial Peripheral Interface, I2C, CAN, USB wireless protocols. Internet Protocol - Introduction to IPv4. Machine Leaning (Python Platform) – Linear Regression, Logistic Regression. Decision Tree. Internet of Things: IoT Protocols – Logical Design - Enabling Technologies - Levels – IoT vs M2M – Design Methodology. Real-time Operating Systems (RTOS): Basic concepts of RTOS and its types.

Reference:

1. Muhammad Ali Mazidi, Shujen Chen, SarmadNaimi and SepherNaimi, TiTiva Arm Programming for Embedded Systems: Programming Arm Cortex-M4 TM4C123G with C: Volume 2, 2017
2. Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects) 1st Edition, Kindle Edition 2015.
3. Frank Vahid, Tony Givargis “Embedded system Design A unified Hardware / software introduction, Wiley 2007.
4. John Paul Muelle, Machine Learning (in Python and R) For Dummies Wiley 2016.

ICE 5005 HYBRID DYNAMICAL SYSTEMS [4 0 0 4]

Dynamical Systems:Linear versus nonlinear systems, Lagrangian and Hamiltonian systems, bifurcation theory, Notations and basic concepts, Finite Automata and Discrete dynamics, Set valued Maps and Differential Inclusions. Hybrid Dynamical Systems: Hybrid time sets and trajectories, Autonomous Hybrid Automata. Modeling of Hybrid Systems: Continuous and Symbolic Dynamics, Hybrid Automaton, General hybrid automaton, Hybrid time evolution and hybrid behavior, Event-flow formulas. Complementarity Systems: Existence and Uniqueness of solutions, Mode selection problem, Linear complementarity systems, Mechanical Complementarity systems, Relay systems. Analysis and Control of Hybrid Systems:Correctness and reachability, , Switching control, PWM control, sliding mode control, Hybrid feedback stabilization.

Reference:

1. Arjan -van der Schaft, Hans Schumacher, An Introduction to Hybrid Dynamical Systems, Springer-2000.
2. Andrzej Indrezejczak, Natural deduction, hybrid systems and modallogics, Springer, 2010.
3. Robert L Grossman, Anil Nerode, Anders P Ravn, Hans Rischel Hybrid Systems, Springer, 1993.
4. Paulo Tabuada Verification and Control of Hybrid Systems: A Symbolic Approach, Springer, 2009.

ICE 5006 INDUSTRIAL AUTOMATION [4 0 0 4]

Plant wide control systems, Instrumentation Standard, HART Protocol, Foundation Fieldbus H1, PLC Configuration, Interfacing PLC to SCADA/DCS, Protocols (Modbus ASCII/RTU) and OPC, Computer Numerically Controlled (CNC) Machines, Distributed Control System, DCS configuration and programming, reporting, alarm management, diagnosis, Historical database management, security and user access management, communication, third party interfaces ,control, display etc. Enhanced functions like Advance process control, fuzzy logic, ANN.

Reference:

1. N.E. Battikha, The management of control system: Justification and Technical Auditing, ISA Publication, 1992
2. S.K.Singh, Computer aided process control, PHI, 2004
3. Samuel Herb, Understanding Distributed Processor Systems for Control, ISA Publication, 1999
4. Webb and Reis, Programmable Logic Controllers: Principles and Applications, PHI, 1995
5. Garry Dunning, Introduction to Programmable Logic Controllers, Thomson Learning, 2001
6. Popovik, Bhatkar, Distributed computer control for industrial automation, Marcel and Dekkar Pub, 1990

ICE 5007 OPTIMAL CONTROL [4 0 0 4]

Problem formulation, Performance measure, Dynamic programming: Optimal control law, Principle of optimality, optimal control problem, interpolation, Discrete linear regulator problem, Hamilton Jacobi Bellmann equation, continuous linear regulator problem, Calculus of Variations: functionals involving single and several independent functions, Variational Approach to Optimal Control Systems. Linear Regulator problems, Pontryagin's minimum principle and state inequality constraint, Time Optimal Control Systems, Fuel-Optimal Control Systems, Numerical determination of optimal trajectories: Two point boundary value problem, Method of steepest descent, variation of extremals, quasilinearization.

Reference:

1. Donald E. Kirk, Optimal Control Theory: An Introduction, Dover Publications, 1998

2. David G. Hull, Optimal Control Theory for Applications, Springer International, 2003
3. Frank L.Lewis, Applied Optimal Control and Estimation, Prentice Hall, 1992
4. Brian D.O. Anderson, Optimal Control: Linear Quadratic Methods, PHI, 1990
5. D. S. Naidu, Optimal Control Systems, (1e), CRC Press, 2003

ICE 5008 ROBOTICS AND AUTOMATION [4 0 0 4]

Definition and origin of robotics – different types of robotics – degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots. Power Sources and Sensors: Hydraulic, pneumatic and electric drives – path determination – micro machines in robotics – machine vision – Manipulators, Actuators and Grippers: Construction of manipulators – manipulator dynamics and force control – end effectors – U various types of grippers. Kinematics and Path Planning: Solution of inverse kinematics problem –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.

Reference:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G Industrial Robotics, McGraw-Hill Singapore. 1996
2. Ghosh Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai.1998
3. Deb.S.R, Robotics technology and flexible Automation, John Wiley, USA. 1992
4. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA. 1992
5. Klafter R.D., Chimielewski T.A., Negin M Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi. 1994

ICE 5009 ROBUST AND H∞ -CONTROL [4 0 0 4]

Norms for signals and systems, Singular Value Decompositions, Condition for Internal stability, Sensitivity and Complementary Sensitivity function Asymptotic Tracking, Uncertainty and Robustness, Robust Stability, Robust Performance. Linear Fractional Transformation: Interconnections of state-space LFTs. - Synthesis Method, structured Robust stability and Performance. Controller Parameterization, Loopshaping with C, Shaping S, T. Model Matching, The Nevanlinna-Pick Problem, Nevanlinna's Algorithm, Design for Performance, Spectral Factorization, Solution of The Modified Problem, Design Examples. H∞ -Control, Minimum Entropy Controller, H∞ -Controller Reductions Techniques. H∞ -Loop Shaping: Robust Stabilization of Coprime Factors, Loop-shaping Design.

Reference:

1. Doyle, J.C., B.A. Francis, Feedback Control Theory, Macmillan publishing co. 1990
2. Kemin Zhou, Doyle J.C, Robust and Optimal Control, Prentice Hall Inc., New Jersey. 1995
3. Willian A. Wolovich , Automatic Control Systems, Saunders college publishing. 1994
4. Kemin Zhou and Doyle J.C, Essential of Robust Control, Prentice Hall Inc, New Jersey, 1997.
5. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Addison Wesly Longman. Inc 1998
6. D.-W. Gu, P.Hr. Petkov and M.M. Konstantinov, Robust Control Design with MATLAB, Springer(India) Private limited. 2006.

OPEN ELECTIVES

ICE 5052 ROBUST CONTROL [3 0 0 3]

Sources of Model Uncertainties, The Robustness of SISO Systems, Robust Multivariable Control Systems , Matrix Decompositions; Norms, Multivariate Optimization Methods, Computer Aided Design and Analysis, Analysis of Robust Control Systems, Parametric Uncertainties, Critical Perturbation Radius (CPR) Theory, Design of Robust Control Systems, MPDA and the Characteristic Locus Design Method, The Q-Parametrization, Introduction to H-infinity Optimal Control, Introduction to μ-synthesis, Advanced methods of control system analysis and design. LQR, LQG, and L1 optimization techniques. Robust control theory including QFT, H-infinity, and interval polynomial approaches, Research Directions

Reference:

1. Kemin Zhou, John Doyle, Essentials of Robust Control, Prentice-Hall, 1998 Skogestad S., Postlethwaite I.
2. Multivariable Feedback Control: Analysis & Design, second edition, 2005.
3. John.C.Doyle, “Feedback Control Theory” Macmillan, 1992.

ICE 5053 VIRTUAL INSTRUMENTATION [3 0 0 3]

Introduction to LabVIEW: Software environment, Modular Programming: Modular programming in LabVIEW, creating an icon, creating subVIs from sections of VIs, creating stand alone applications. Strings and File I/O: creating string controls and indicators, string functions, Instrument Control: GPIB communication, hardware and software architecture and specifications, instrument I/O assistant, Data Acquisition: Transducers, signal conditioning, DAQ hardware configuration, DAQ hardware, IMAQ Vision: Vision basics, image processing and analysis, building a complete machine vision system.

Reference:

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill. 1997

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING, MIT Manipal

M.Tech. AEROSPACE ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5156	Applied Linear Algebra and Probability	4	0	0	4	ICE 5271	Flight Mechanics	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	ICE 5272	Spacecraft Dynamics and Control	4	0	0	4
	ICE 5171	Aerospace System Modelling	4	0	0	4	ICE ****	Elective I	4	0	0	4
	ICE 5172	Control System Design	3	1	0	4	ICE ****	Elective II	4	0	0	4
	ICE 5173	Navigation and Guidance of Aerospace Vehicles	4	0	0	4	ICE ****	Elective III	4	0	0	4
	ICE 5174	Orbital Mechanics	3	1	0	4	*** ****	Open Elective	3	0	0	3
	ICE 5161	Control System Design Lab	0	0	3	1	ICE 5263	Aerospace System Simulation Lab – II	0	0	3	1
	ICE 5164	Aerospace System Simulation Lab - I	0	0	3	1	ICE 5264	Space Dynamics Lab	0	0	3	1
	ICE 5165	Numerical Methods for Trajectory Design Lab	0	0	3	1						
		Total	**19**	**2**	**12**	**25**		**Total**	**23**	**0**	**6**	**25**
II	**THIRD AND FOURTH SEMESTER**											
	ICE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
ICE 5001	Advanced Sensor Technology	ICE 5013	Satellite Communication Systems
ICE 5007	Optimal Control	ICE 5014	Soft Computing Techniques
ICE 5008	Robotics and Automation	ICE 5015	Space Environment and System Degradation in Space
ICE 5010	Discrete and Nonlinear Control Systems	ICE 5016	Space Mission Analysis and Design
ICE 5011	Flight Instrumentation	ICE 5017	Spacecraft Engineering
ICE 5012	Rendezvous and Docking of Spacecrafts	ICE 5018	System Identification

OPEN ELECTIVES			
ICE 5052	Robust Control	ICE 5053	Virtual Instrumentation

SEMESTER I

MAT 5156 APPLIED LINEAR ALGEBRA AND PROBABILITY [4 0 0 4]

Finite dimensional vector space, subspaces, linear independence, bases and dimension, Algebra of transformations, range and null space of a linear transformation, matrix algebra, simultaneous equations. Sum and intersection of subspaces, direct sum of invariant subspaces, eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Sylvester's interpolation method, various canonical form. Algebra of polynomial matrices, invariant. Polynomial matrices, invariant polynomials, Smith canonical form. Inner-product spaces, Gram Schmidt orthogonalization, decomposition, Some computational methods of linear algebra., Probability theory: Review of Set theory; introduction to probability, axioms of probability; joint and conditional probability; Bayes theorem.

Reference:

1. P.L.Meyer, Introductory to probability and Statistical Applications. Addison-Wesley Publishing Company, 1970.
2. Finkbeiner D.T. I, Introduction to Matrices and linear Transformation, D.B. Taraorewala's, 1968.
3. Hoffman, K and Kunze, R, Linear Algebra, Prentice Hall of India 1972.
4. Gantmocher F.R., The Theory of Matrices, Cheisea, 1960.
5. Goult, R.J., Hoskin, R.P., Milner, J.A and Pratt, M.J, Computational methods in Linear Algebra, Stanley Thomas Pub. Ltd., 1974.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology, Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation, Criteria of a good research problem. Characteristics and Types of hypothesis, Procedure for hypothesis testing., Introduction to various sampling methods and their applications. Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis, Writing thesis, Writing journal and conference papers, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

Reference:

1. Dr. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R.Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W.Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004.
4. Suresh C.Sinha and Anil K.Dhiman, Research Methodology (2Vols-Set), Vedam Books, 2006.
5. C.R.Kothari, Research Methodology; Methods and Techniques, New Age International Publisher, 2008.

ICE 5171 AEROSPACE SYSTEM MODELLING [4 0 0 4]

Basic Aerodynamics, Incompressible and compressible flow, Momentum equation, Mach number, Aerodynamic forces over the wing surfaces, Stalling of airfoil, Lift-to-drag ratio, Aspect ratio, Drag polar, Modeling of Aircrafts, Forces and Moments, Aerodynamic coefficients, Equations of motion for straight, level and un-accelerated flight, Aircraft force and Moment equations. Missile dynamics, Force and Moment equations, Translational and rotational equations, Modeling helicopter and Quadcopter dynamics, Position and orientation dynamics. Dynamic model of a quadcopter.

Reference:

1. R C. Dorf and R H. Bishop, Modern Control Systems, 12th Edition, Pearson Publication, 2014
2. John. D. Anderson, Introduction to Flight, 6th Edition, McGraw Hill Education, 2010
3. G.D Padfield, Helicopter flight dynamics, 2nd Edition, Blackwell Publishing, 2007
4. George. M. Siouris, Missile Guidance and Control System, Springer, 2004
5. Marcel. J. Sidi, Spacecraft Dynamics and Control, Cambridge University Press, 1997

ICE 5172 CONTROL SYSTEM DESIGN [3 1 0 4]

Time and Frequency domain performance specifications, Steady state error coefficients, Compensator design using Root Locus and Bode plots. PID controller characteristics, design principles. State variable methods, Modeling of systems, Invariance property, transfer function, Eigen values, Eigen vectors, diagonalization, Solution of state equations, state transition matrix, Cay ley Hamilton method, zero state and zero input responses, total response for standard inputs. Controllability, observability, duality, pole placement-direct method, Ackerman's formula, State observers, Full order observer design, separation principles, Lyapunov stability.

Reference:

1. K Ogata, Modern Control Engineering 5 edition, Pearson education, 2011
2. M Gopal, Digital Control and State Variable methods, 3 edition Tata McGraw-hill, 2008
3. Les Fenical, Control Systems, Cengage Learning, India Edition, 2007
4. C.T. Chen Analog and Digital control System Design, Oxford University Press,2006.

ICE 5173 NAVIGATION AND GUIDANCE OF AEROSPACE VEHICLES [4 0 0 4]

Introduction to NGC, NGC Loop, Applications, Navigation Systems - Basic Principle of Navigation and Position fixing, Deck Reckoning Navigation, Inertial Navigation, Inertial Platforms, Strapdown systems. Radio and Satellite Navigation, Air Navigation Radio aids, Radar, Integrated Navigation, Navigation equations. Navigation Sensors, Gyroscopic Instruments, Precession and Nutation, Force Sensors, Angular rate sensors, Guidance and Control Systems, Different Phases of Guidance, Intercept geometry, Homing Guidance, Proportional Navigation Guidance, Command Guidance, Target intercept rules in guidance strategy, Fundamental Guidance Equations, Missile control.

Reference:

1. Anthony Lawrence, Modern Inertial Technology, (2ed), Springer, 1998
2. David H Titterton, Strapdown Inertial Navigation Technology, (2ed), IEE, 2004.
3. D. Biezad, Integrated Navigation and Guidance Systems, AIAA, 1999
4. Blakelock, Automatic Control of Aircraft & Missile, John Wiley and Sons, 1991
5. George M. Siouris, Missile Guidance and Control Systems, Springer, 2004

ICE 5174 ORBITAL MECHANICS [3 1 0 4]

Two-body orbital mechanics, Constants of the motion, Trajectory equation, Types of orbit, Canonical units. Coordinate systems, Classical orbital elements, Orbit determination, Space surveillance, Type and location of sensors, Ground track of a satellite. The Gauss problem, Solution of the Gauss problem, Orbital maneuvers, Sensitivity analysis, Thrust transfer, Bi-elliptical transfer, Propulsion for maneuvers. Interplanetary trajectories, Departure orbits, Transit orbits, Arrival orbit, Flyby maneuvers, Non-coplanar interplanetary trajectories, Lunar trajectories, Three-body problem, Isomass and Euler configuration, Lagrange configuration, Restricted three-body problem, Jacobi's integral, Stability and dynamics at Eulerian points, Orbit perturbations, Numerical integration methods, Analytic formulation of perturbative accelerations.

Reference:

1. Roger R. Bate, Donald D. Mueller, Jerry E. White, Fundamentals of Astrodynamics, Dover publications, New York, 1971.
2. Marshall H. Kaplan, Modern spacecraft dynamics and controls, John wiley and sons, 1976
3. W.E. Wiesel, Spacecraft dynamics, McGraw-Hill, 1996
4. Ulrich Walter, Astronautics, Wiley, 2005
5. Charles D. Brown, Spacecraft Mission design second edition, AIAA education series, 1998

ICE 5161 CONTROL SYSTEM DESIGN LAB [0 0 3 1]

Block diagram reduction, Time domain and Frequency domain analysis, Stability analysis, Compensator design using Root locus and Bode plot, Pole Placement, DC Motor control, PID controller Characteristics, Compensator design Temperature control.

Reference:

1. K Ogata, Modern Control Engineering 5 edition, Pearson education, 2011
2. M Gopal, Digital Control and State Variable methods, 3 edition Tata McGraw-hill, 2008
3. Les Fenical, Control Systems, Cengage Learning, India Edition, 2007
4. C.T. Chen Analog and Digital control System Design, Oxford University Press, 2006.

ICE 5164 AEROSPACE SYSTEM SIMULATION LAB - I [0 0 3 1]

Modeling, Simulation and control implementation for Ball and Beam Systems, Modeling, Simulation and control implementation for Magnetic Levitation system, Modeling, Simulation and control implementation for Twin Rotor MIMO system, Modeling, Simulation and control implementation for 3DOF Helicopter System.

Reference:

1. Technical Manual for Ball and Beam System, Maglev system, Twin Rotor MIMO system, 3DOF helicopter System and dSpace Control software provided by the respective company manual.
2. R C. Dorf and R H. Bishop, Modern Control Systems, 12th Edition, Pearson Publication, 2014
3. John. D. Anderson, Introduction to Flight, 6th Edition, McGraw Hill Education, 2010
4. G.D Padfield, Helicopter flight dynamics, 2nd Edition, Blackwell Publishing, 2007

ICE 5165 NUMERICAL METHODS FOR TRAJECTORY DESIGN LAB [0 0 3 1]

Locating Roots of Equations, Systems of Linear Equations, Matrix factorization, Interpolation and Numerical Differentiation, Numerical integration, Solution of Linear and nonlinear differential equation, Initial value problem using MATLAB, Curve fitting with polynomial functions using MATLAB, Find the functional relationship between variable using interpolation, Monte Carlo Methods and Simulation, Case Study of Trajectory design.

Reference:

1. Ward Cheney and David Kincaid, Numerical Mathematics & Computing (5e), Brooks/Cole, 2004.
2. Van Loan, Introduction to Scientific Computing (2e), Prentice Hall, 1999
3. Rudra Pratap, Getting started with MATLAB 7, Oxford university press 2007
4. Duane C. Hanselman and Bruce L. Littlefield, Mastering MATLAB 7

SEMESTER II

ICE 5271 FLIGHT MECHANICS [4 0 0 4]

Review on Longitudinal and lateral equations of motion, Aircraft performance, Thrust and Power required for un-accelerated flight, Rate of climb, Gliding flight, Take-off and Landing performance, Turning flight and V-n Diagram. Longitudinal, directional and lateral static stability, stability modes, dynamic stability, autopilot, Control augmentation systems, Fly-by-wire systems.

Reference:

1. John. D. Anderson, Introduction to Flight (6/e), McGraw Hill Education, 2010.
2. Thomas. R. Yechout, Introduction to Aircraft Flight Mechanics (1/e), AIAA Education, 2003.
3. Michael. V. Cook, Flight Dynamics Principle (2/e), Butterworth, Heinemann, USA, 2007.
4. Brian L. Stevens and Frank L. Lewis, Aircraft control and simulation (2/e), Wiley India, 2003.
5. John. H. Blakelock, Automatic control of Aircraft and Missiles, Wiley, 1991.

ICE 5272 SPACECRAFT DYNAMICS AND CONTROL [4 0 0 4]

Attitude Dynamics and Kinematics, Rotational motion of spacecraft, attitude parameters and spacecraft torques, attitude motions of simple space-crafts and their stability, Single- and Dual-Spin Stabilization, attitude sensors and control actuators, Gravity-gradient stabilization, Equations for basic control laws, control with momentum exchange devices, magnetic attitude control, time-optimal attitude control, stabilization with and without active control, Roll-Yaw attitude control with magnetic torques and reaction thruster, Active nutation damping, Reaction torques and attitude control loops.

Reference:

1. Bong Wie, Space Vehicle Dynamics and Control, AIAA Education Series, 1998.
2. W. E. Wiesel, Spacecraft Dynamics, McGraw-Hill, 1996.
3. A. E. Roy, Orbital Motion, Bristol, England, Adam Hilger, 1988
4. M. M. Kaplan, Modern Spacecraft Dynamics Control, Wiley, 1976

ICE 5263 AEROSPACE SYSTEM SIMULATION LAB – II [0 0 3 1]

Six DOF simulation of aircraft flight path, Aerospace embedded system design using ARM controller, Missile guidance experiments using MATLAB, Flight data acquisition experiments using LabVIEW.

Reference:

1. Thomas. R. Yechout, Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability, and Classical Feedback Control, AIAA, 2003.
2. Paul Zarchan, Tactical and Strategic Missile Guidance (6E), AIAA, 2012.
3. Ward Cheney and David Kincaid, Numerical Mathematics & Computing (5e), Brooks/Cole, 2004.
4. Van Loan, Introduction to Scientific Computing (2e), Prentice Hall, 1999.
5. Duane C. Hanselman and Bruce L. Littlefield, Mastering MATLAB 7

ICE 5264 SPACE DYNAMICS LAB [0 0 3 1]

Computation Astrodynamics, Solution of Kepler's Equation, orbital elements from the state vector , Orbit determination using Gibbs method, analysis of Spacecraft relative motion, gravity-turn trajectory, orbital Maneuvers, Earth-to-Mars Mission Design, Earth-to-Moon Mission Design, Analysis of Orbital Elements and Spacecraft Trajectory using Orbwin

Reference:

1. Howard D Curtis, Orbital Mechanics for Engineering Students, (2e), Elsevier Aerospace Series
2. Ward Cheney and David Kincaid, Numerical Mathematics & Computing (5e), Brooks/Cole, 2004.
3. Charles D Brown, Spacecraft Mission Design, AIAA series.

SEMESTER III & IV

ICE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

ICE 5001 ADVANCED SENSOR TECHNOLOGY [4 0 0 4]

Advanced sensing techniques, Sensor classifications, advanced sensing materials, Optical Sensors: Fiber optic light propagation, Graded index fibers, Fiber optic communication driver circuits, Laser classifications, Driver circuits MEMS sensor, Fabrication and packaging issues, Thick film and thin film technique. Physical sensors: Hall Effect sensors, Eddy current sensors, magneto resistive and magnetostrictive detector. Aerospace Sensor: Accelerometers: Thermal, Humidity and moisture sensor Proximity detectors using polarized light, Semiconductor gas sensor. Fluidic and Micro-fluidic sensors, Gyroscope laser. Chemical sensor: Chemical sensor characteristics, Classification of Chemical sensing mechanism, potentiometric sensors, conductive sensors, amperometric sensors, enhanced catalytic gas sensors, engyme sensors. Lab on chip/senor platform technology. The role of PCA, LDA, Neural network in designing sensor array.

Reference Books:

1. Sabaree Soloman, Sensors Hand Book, McGraw Hill, 1998
2. Culshaw B and Dakin J (Eds) Optical Fibre Sensors, Vol. 1 & 2 Artech House, Norwood, 1989.
3. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 2010.
4. P Ripka, A Tipek, Modern Sensors Handbook. Wiley Publication, 2007.
5. Julian W Gardner, Vijay K Varadan, Microsensors, MEMS and Smart Devices, John Wiley & Sons, Inc. New York, 2001.

ICE 5007 OPTIMAL CONTROL [4 0 0 4]

Problem formulation, Performance measure, Dynamic programming: Optimal control law, Principle of optimality, optimal control problem, interpolation, Discrete linear regulator problem, Hamilton Jacobi Bellmann equation, continuous linear regulator problem, Calculus of Variations: functionals involving single and several independent functions, Variational Approach to Optimal Control Systems. Linear Regulator problems, Pontryagin's minimum principle and state inequality constraint, Time Optimal Control Systems, Fuel-Optimal Control

Systems, Numerical determination of optimal trajectories: Two point boundary value problem, Method of steepest descent, variation of extremals, quasi-linearization.

Reference:

1. Donald E. Kirk, Optimal Control Theory: An Introduction, Dover Publications, 1998
2. David G. Hull, Optimal Control Theory for Applications, Springer International, 2003
3. Frank L.Lewis, Applied Optimal Control and Estimation, Prentice Hall, 1992
4. Brian D.O. Anderson, Optimal Control: Linear Quadratic Methods, PHI, 1990
5. D. S. Naidu, Optimal Control Systems, (1e), CRC Press, 2003

ICE 5008 ROBOTICS AND AUTOMATION [4 0 0 4]

Definition and origin of robotics – different types of robotics – degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots. Power Sources and Sensors: Hydraulic, pneumatic and electric drives – path determination – micro machines in robotics – machine vision – Manipulators, Actuators and Grippers: Construction of manipulators – manipulator dynamics and force control – end effectors – U various types of grippers. Kinematics and Path Planning: Solution of inverse kinematics problem –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.

Reference:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G Industrial Robotics, McGraw-Hill Singapore. 1996
2. Deb.S.R, Robotics technology and flexible Automation, John Wiley, USA. 1992
3. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA. 1992
4. Klafter R.D., Chimielewski T.A., Negin M Robotic Engineering – An integrated approach, Prentice Hall of India, 1994
5. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, 1998

ICE 5010 DISCRETE AND NONLINEAR CONTROL SYSTEMS

Discrete time control, Z transforms, Difference equation, pulse transfer function, Block diagram reduction, signal flow graph, steady state errors, Mappping between s- and z- plane, stability, Transient and steady state analysis, Root locus and Bode plot of Discrete time systems. Discrete PID controllers. State variable analysis of discrete time systems, stability, eigen values, eigen vectors, Transformation to Canonical forms, Minimal realization, State transition matrix, solution of state equations, pole placement, Observers. Nonlinear system behaviour, phase plane, phase portraits, phase plane analysis of nonlinear systems, singular points, limit cycles, stability, Lyapunov theory, Lyapunov's direct method, Lyapunov analysis of linear time invariant systems, stability analysis of non linear systems, Krasovskii's method, Linearization Methods

Reference Books:

1. K. Ogata, Discrete time control Systems, 2nd Edition, PHI, 2005
2. M Gopal, Digital Control and State Variable methods, 3rd Edition, Tata McGraw-hill, 2008
3. K. Ogata, Modern Control Engineering, 5th Edition, PHI, 2010
4. M. Gopal, Modern Control System Theory, New Age International,1993

ICE 5011 FLIGHT INSTRUMENTATION (4 0 0 4)

Axes system Parts, importance and role of Avionics systems which interface directly with pilot, Aircraft state sensor systems, Navigation systems, External world sensor systems, task automation systems. Avionics architecture evolution. Avionics Data buses - MIL STD 1553, ARINC 429, and ARINC 629. Radio Navigation , Inertial and satellite navigation systems, Air data systems and autopilot: Air data quantities Aircraft Displays, Virtual cockpit.

Reference:

1. Albert Helfrick. D, 'Principles of Avionics', Avionics communications Inc., 2004
2. Collinson, R.P.G, 'Introduction to Avionics', Chapman and Hall, 1996.
3. Middleton, D.H, 'Avionics Systems', Longman Scientific and Technical, Longman Group UK Ltd, England, 1989.
4. Spitzer, C.R. 'Digital Avionics Systems', Prentice Hall, Englewood Cliffs, N.J., USA 1993.
5. Spitzer, C.R, 'The Avionics Handbook', CRC Press, 2000.

ICE 5012 RENDEZVOUS AND DOCKING OF SPACECRAFTS (4 0 0 4)

Complexity of rendezvous process, Different phases of rendezvous mission, Impulsive and Continuous maneuvers. Design rules for trajectory safety, Trajectory disturbances, Protection against trajectory deviations, Collision avoidance maneuvers, Rendezvous Control System Navigation filter, Guidance function and Control function, Mode sequencing and equipment management, Fault identification and recovery concepts, Basic measurement requirements and Concepts, Basic concepts of docking and Berthing – Types of docking and berthing mechanisms, Contact dynamics, Capture devices, Elements of final connection, Space and Ground Station System Setup – Functions and task of space and ground segments, Ground segment monitoring and control functions for RVD, RVD verification/ validation during development life cycle

Reference:

1. Wigbert Fehse, Automated Rendezvous and Docking of Spacecraft, Cambridge University Press, 2003.
2. Bong Wie, Space Vehicle Dynamics and Control - 2nd Edition, AIAA Education Series, 1998.
3. Marcel J. Sidi, Spacecraft Dynamics and Control, Cambridge University Press, 1997.

ICE 5013 SATELLITE COMMUNICATION SYSTEMS [4 0 0 4]

Satellite Systems, System design considerations, Laws governing satellite motion, geostationary satellites, Non-geostationary constellation, Launching of geostationary satellites. Equitable use of radio Spectra, propagation considerations: Communication Link design – Antenna basics, Communication satellites Design consideration - Lifetime and reliability, Space craft subsystems, Space craft mass and power estimating, space segment cost estimates, space craft development programs, Earth Station, Non-geostationary orbit satellite systems, Thermal Control, Alternative power sources for spacecraft; Solar array components; batteries; outline of power control methods; degradation of power system performance.

Reference:

1. M Richharia, Satellite Communication Systems Design Principles, (2e), McGraw Hill Inc, USA, 1995.
2. Timothy Pratt and Charles W Bostan, Satellite Communications John Wiley and Sons, 1986.
3. Dennis Roddy, Satellite Communications(4e) McGraw Hill Telecom Engg, 2006.

ICE 5014 SOFT COMPUTING TECHNIQUES [4 0 0 4]

Fuzzy Relations – Fuzzy logic and approximate reasoning – Design Methodology of Fuzzy Control Systems – Models and Learning rules of ANN's. Single layer perceptron networks – Feedback networks – Supervised and unsupervised learning approaches – Neural Networks in Control Systems. Neural Realization of Basic fuzzy logic operations – Neural Network based fuzzy logic inference – Neural Network based Fuzzy Modelling – Types of Neural Fuzzy Controllers. Fuzzy logic based Neural Network Models: Fuzzy Neurons – Type I, Type II, Type III –Fuzzification of Neural Network Models – Fuzzy Perceptron and Fuzzy classification with back propagation network, Neural Networks with fuzzy training – Fuzzy Neural clustering.

Reference:

1. Jyh Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine, Prentice Hall. 1997
2. Chin –Teng Lin and C.S. George Lee, Neural Fuzzy Systems" – A neuro fuzzy synergism to Intelligent systems, Prentice Hall International. 1996
3. Yanqing Zhang and Abraham Kandel, Compensatory Genetic Fuzzy Neural Networks and Their Applications, World Scientific. 1998.
4. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc. 1995
5. R. Horst, Global Optimization, Springer Publications, 2nd Edition

ICE 5015 SPACE ENVIRONMENT AND SYSTEM DEGRADATION IN SPACE [4 0 0 4]

Classification of spacecraft environments ,Spacecraft orbits and environment, Ambient space environment, Neutral gas interactions, Earth's atmosphere, Atmospheric drag, Spacecraft glow, Atmospheric models Plasma interaction and characteristics, Sputtering, Spacecraft charging, Spacecraft grounding, Electrodynamic tethers, Radiation interactions, Spacecraft contamination analysis and control, planetary protection, Meteoroids and Space debris, Shields and bumpers, Thermal control, Spacecraft thermal environments, Conduction, convection and radiation. Spacecraft design,

Reference:

1. Daniel Hastings, Henry Garrett, Spacecraft-environment interactions, Cambridge University Press, (1e), 1996.
2. Vincent L Pisacane, The space environment and its effects on space systems, AIAA education series, (2e), 2008.
3. P. W. Fortescue & J P W Stark, Spacecraft Systems Engineering, John Wiley & Sons, 2011
3. P.W. Fortescue& J P W Stark, Spacecraft Systems Engineering, John Wiley and sons, (4e), 1991.

ICE 5016 SPACE MISSION ANALYSIS AND DESIGN [4 0 0 4]

The Space Mission Life Cycle, Definition of Mission, Objectives, Preliminary Estimate of Mission Needs, Requirements and Constraints, Identifying Alternative Mission Concepts and Mission Architecture, Identification of Critical Requirements, Mission Analysis, Mission Utility, Mission Concept Selection, Space Mission Geometry, Attitude Determination and Control, Telemetry, Tracking and Command, Command and Data Handling, Power, Thermal, Structures and Mechanisms, Guidance and Navigation, Ground System Design and Sizing, Spacecraft Computer Systems, Space Propulsion Systems, Launch Systems, Communication systems, Developing a Mission Operations Plan, Launch Site Operations, Overview of Space Mission Operations Functions, Automating Spacecraft and Ground Operations Functions.

Reference:

1. James R. Wertz & Wiley J. Lason, Space Mission Analysis and Design, Microcosm/Kluwer-1999
2. Thomas P. Sarafin, Spacecraft Structures and Mechanisms, Microcosm/Kluwer-1995
3. Bang Wie, Space Vehicle Dynamics and Control, AIAA Education Series-1998
4. George P. Suttan-Rocket Propulsion Elements: An Introduction to the Engineering of Rockets, John Wiley and Sons-2001
5. Charles D. Brown Spacecraft Mission Design, -AIAA Education Series-1998

ICE 5017 SPACECRAFT ENGINEERING [4 0 0 4]

System view of spacecraft, Space environment and its effect on design, space vehicle motion: Rocket principle, rocket thrust, Rocket equation of motion, Rocket flight, Rocket staging, Ascent flight, density master equation, Equations of motion of a spacecraft flight, Propulsion systems, chemical rockets, Propellants, propellant grain geometry, Chemical rocket design, Secondary propulsion, Electric propulsion, Spacecraft structures, Material selection, Attitude control, Torques and torquers, Attitude measurement, Electrical power systems, Power management, distribution and control, Thermal control of spacecraft, Thermal environment and balance, Thermal analysis and design, Telecommunications, Techniques of radio communications, The Communications payload, Telemetry, Command, Data handling and Processing, Telemetry data formatting, Telecommand, Communication techniques and protocols, On-board data handling and processing, Spacecraft mechanisms, one-shot devices, Continuously and intermittently operating devices, Components, materials

Reference:

1. P. W. Fortescue & J P W Stark, Spacecraft Systems Engineering, John Wiley & Sons, 2011
2. Ulrich Walter, Astronautics, Wiley-VC, 2005
3. George P Sutton, Oscar Biblarz, Rocket Propulsion Elements, (7e), John Wiley and sons, 2001
4. Charles D Brown, Elements Of Spacecraft Design-AIAA education series. 2002
5. Thomas P Sarafin , Spacecraft Structures And Mechanisms,(2e), Microcosm, Inc. and Kluwer Academic publishers. 1997

ICE 5018 SYSTEM IDENTIFICATION [4 0 0 4]

Classification of inputs and system models, coupling of subsystems, linearization, Analytical and experimental methods of modelling, Response to random inputs, state-space models, pseudo-random signal testing parameter tracking, regression and least-square methods, FIR and ARX models, development of ARX models by least square estimation, unmeasured disturbance modeling, system identification procedure, Non-parametric time and frequency domain methods, parameter estimation method, convergence and consistency, computing the estimate, recursive estimation methods.

Reference:

1. E.O. Doeblin, System Modelling and Response, John Wiley Sons, 1980
2. Desai and Lalwani, Identification Techniques, Tata McGraw Hill, 1977
3. L. Ljung, System Identification: Theory for the User, Prentice Hall, 1992
4. Philip D. Cha, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge, 2000.

OPEN ELECTIVES

ICE 5052 ROBUST CONTROL [3 0 0 3]

Sources of Model Uncertainties, The Robustness of SISO Systems, Robust Multivariable Control Systems, Matrix Decompositions; Norms, Multivariate Optimization Methods, Computer Aided Design and Analysis, Analysis of Robust Control Systems, Parametric Uncertainties, Critical Perturbation Radius (CPR) Theory, Design of Robust Control Systems, MPDA and the Characteristic Locus Design Method, The Q-Parametrization, Introduction to H-infinity Optimal Control, Introduction to μ-synthesis, Advanced methods of control system analysis and design. LQR, LQG, and L1 optimization techniques. Robust control theory including QFT, H-infinity, and interval polynomial approaches, Research Directions

Reference:

1. Kemin Zhou, John Doyle, Essentials of Robust Control, Prentice-Hall, 1998. Skogestad S., Postlethwaite I.
2. Multivariable Feedback Control: Analysis & Design, second edition, 2005.
3. John.C.Doyle, Feedback Control Theory, Macmillan, 1992.

ICE 5053 VIRTUAL INSTRUMENTATION [3 0 0 3]

Introduction to LabVIEW: Software environment, Modular Programming: Modular programming in LabVIEW, creating an icon, creating subVIs from sections of VIs, creating stand alone applications. Strings and File I/O: creating string controls and indicators, string functions, Instrument Control: GPIB communication, hardware and software architecture and specifications, instrument I/O assistant, Data Acquisition: Transducers, signal conditioning, DAQ hardware configuration, DAQ hardware, IMAQ Vision: Vision basics, image processing and analysis, building a complete machine vision system.

Reference:

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill. 1997

Department of Mechanical and Manufacturing Engineering

The Department of Mechanical and Manufacturing Engineering, established in the year 1960, offers two Under Graduate courses, four Post Graduate courses and also PhD programmes. The department is also recognized as a QIP center for post graduate courses and PhD. The department consists of experienced faculty members, who are also constantly engaged in undertaking research work and subsequent publications. The department conducts workshops, seminars or conferences every year. The department has very good industry – institute interaction and has conducted several short courses for working professionals from industry. The department provides ample laboratory facilities and hands-on training to the undergraduate students both in the conventional subject as also in the modern trends.

The department has well established Computer Aided Design laboratory with state – of – the – art hardware and software. The basic laboratories such as Heat engines laboratory, Metrology laboratory, Heat transfer laboratory, Fuel testing laboratory, Machine tools laboratory, Material science laboratory, Vibration laboratory and Industrial engineering laboratory, Energy Laboratory have advanced equipments so as to impart quality education. The department has sprawling workshop situated on a 30000 sqft area comprising of machine shop, CNC shop, foundry, smithy, sheet metal, plumbing, welding sections. The practice school and internship opportunities provide an excellent student industry exposure.

Programs offered

Under Graduate Programs

- B.Tech in Mechanical Engineering (1960)
- B.Tech in Industrial and Production Engineering (1975)

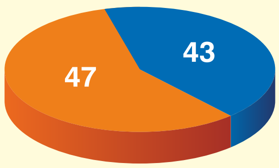
Post Graduate Programs

- M.Tech in Computer Aided Analysis and Design (2003)
- M.Tech in Manufacturing Engineering (2005)
- M.Tech in Thermal Sciences and Energy Systems (2013)
- M.Tech in Tribology and Maintenance (2018)

PhD

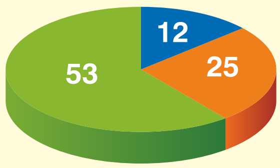
Faculty Strength

Qualification-wise



- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors

DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING, MIT Manipal

M.Tech. COMPUTER AIDED ANALYSIS & DESIGN

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5155	Applied Numerical Methods	3	1	0	4	MME 5282	Lubrication of Bearings	3	1	0	4
I	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	MME 5283	Finite Element Methods	3	1	0	4
I	MME 5181	Advanced Mechanical Vibrations	3	1	0	4	MME ****	Elective I	3	1	0	4
I	MME 5182	Fatigue of Materials	3	1	0	4	MME ****	Elective II	3	1	0	4
I	MME 5183	Geometric Modeling for CAD	3	1	0	4	MME****	Elective III	3	1	0	4
I	MME 5184	Solid Mechanics	3	1	0	4	*** ****	Open Elective	3	0	0	3
I	MME 5168	CAD Lab	0	0	6	2	MME 5267	Finite Element Analysis Lab	0	0	6	2
I	MME 5165	Design Engineering Lab	0	0	3	1						
I		**Total**	**16**	**5**	**12**	**25**		**Total**	**18**	**5**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	MME 6098	Project Work							0	0	0	25
II								**Total**	0	0	0	**25**

PROGRAM ELECTIVES			
MME 5004	Computational Fluid Dynamics	MME 5016	Advanced Mechanisms and Design
MME 5013	Design for Manufacturing	MME 5017	Biomechanics
MME 5014	Fracture Mechanics	MME 5018	Rotor Dynamics
MME 5015	Mechanics of Composite Materials		

OPEN ELECTIVES			
MME 5053	Corrosion Science	MME 5057	Industrial Safety Engineering
MME 5054	Creativity for Product Design	MME 5058	Lean Manufacturing
MME 5055	Design of Experiments	MME 5059	Renewable Energy Technology
MME 5056	Energy Storage Systems		

SEMESTER I

MAT 5155: APPLIED NUMERICAL METHODS [3 1 0 4]

Interpolations, Numerical Differentiation and Integration, Solution of linear and nonlinear system of equations: direct methods and iterative methods, Eigen values & Eigen vectors using Power Method. Numerical Solution of Ordinary Differential Equations, Initial Value Problems: Single step methods. Multi step methods, Boundary Value Problems: Finite difference method. Numerical Solution of Partial Differential Equations, Elliptic P.D.E, Parabolic P.D.E, Hyperbolic P.D.E.

References:

1. Atkinson K. E: An Introduction to Numerical Analysis, edn 3, John Wiley and Sons (1989).
2. Carnahan, Luther and Wikes: Applied Numerical Methods, TMH, New edition (1969).
3. Hilderband F.B: Introduction to Numerical Analysis, Edn 5, Tata McGraw Hill, New Delhi, New edition
4. Conte S.D and Be Door, Introduction to Numerical analysis, McGraw Hill.
5. Gerald C.F. and Patrick D. Wheatley: Applied Numerical Analysis, 3rdedn. 1984, Addison Wesley.
6. J. W. Thomas, Numerical Partial Differential Equations: Finite Difference Methods, Springer Verlag.
7. G. D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univeristy Press.
8. Jain, Iyengar and Jain: Numerical methods for Scientific and Engineering Computations, New Age Publishers.

HUM 5151: RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel , Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler , Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

MME 5181: ADVANCED MECHANICAL VIBRATIONS [3 1 0 4]

Vibration fundamentals, Single degree freedom systems, damping, free and forced vibration, force transmissibility, vibration isolation, two degree freedom systems-dynamic vibration absorber, multidegree freedom system, whirling of shaft**.** Continuous systems, Finite element method, Standard and nonstandard eigenvalue problem, concept of iteration and methods, Rayleigh damping. Nonlinear vibration solution methods, subharmonic & super harmonic oscillations, graphical methods, stability of equilibrium states, limit cycles and chaos, Perturbation method, Duffing's system, VanderPol's systems. Random vibration: Gaussian random process, Fourier analysis, power spectral density, wide band and narrow band processes, response of a single degree of freedom system. Vibration Transducers, electrodynamic and linear variable differential transformer transducers; Vibration pickups, Exciters-mechanical exciters, electrodynamic shaker**,** Signal analysis: modulation, spectrum analysers, bandpass filter, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis.

References:

1. Singiresu S. Rao (2004) "Mechanical Vibrations" 4/e, *Pearson Education Inc.*
2. Ramamurti V. (2000) "Mechanical Vibration Practice with Basic Theory" *Narosa Publishing House*, Chennai
3. Rao J. S. and Gupta K. (1999) "Theory and Practice of Mechanical Vibrations" *New Age International Publishers*
4. Rao J. S. (1992) "Advanced Theory of Vibrations" *Wiley Eastern Limited*, Bangalore
5. Balakumar Balachandran and Edward B. Magrab (2004) "Vibrations" Thomson – Brooks/Cole
6. William T. Thomson (1988) "Theory of Vibrations with Applications" 3/e, *CBS Publishers & Distributors*, New Delhi

MME 5182: FATIGUE OF MATERIALS [3 1 0 4]

Structure and deformation of materials, strategies in fatigue design, fatigue design philosophies, Modes of mechanical failure, fatigue mechanisms and microscopic features, macro aspects of fatigue of metals. *Stress-life approach:* Stress-life (S-N) curves, fatigue limits, mean stress effects on S-N behavior, factors influencing S-N behavior, S-N curve representation and approximations, stress concentration effects, notch sensitivity factor, Life estimation using S-N approach. Cumulative damage theories and life prediction. *Cyclic deformation and Strain-life approach:* Monotonic stress-strain behavior, cyclic stress-strain behavior, cyclic stress-strain curve determination, stress-plastic strain power law relationship, fatigue crack initiation in ductile solids, cyclic deformation and crack initiation in brittle solids. Strain-life curve, determination of fatigue properties, transition life, mean stress effects and strain life equations, notch stresses and strains, notch strain analysis- Neuber's rule, fatigue testing procedures and statistical analysis of fatigue data. *Variable amplitude loading:* Fatigue from Variable amplitude loading – damage quantification, load interaction and sequence effects, cycle counting methods. *Multi-axial fatigue:* States of stress and strain, proportional versus non-proportional loading, multi-axial theories.*Effect of temperature on fatigue:* Low-temperature fatigue, high-temperature fatigue, Thermo-mechanical fatigue. *Fatigue of weldments:* Stress-life & strain-life behaviors, improving fatigue resistance, life estimation. Fatigue life extension methods.

References:

1. Stephens Ralph I, Fatemi Ali, Stephens Robert R and Henry, *Metal Fatigue in Engineering*, (2e), John Wiley and Sons Inc, New York, 2001.
2. Norman E Dowling, *Mechanical Behaviour of Materials,* (4e), Prentice Hall, 2012.
3. Suresh S, *Fatigue of Materials*, (2e), Cambridge University Press., UK, 1998.
4. Julie A Bannantine, Jess J Comer and James L Handrock, *Fundamentals of Metal fatigue and Analysis*, Prentice Hall, 1990.
5. Jack A Collins*, Failure of Materials in Mechanical Design*, (2e), John Wiley & Sons., New York, 1993.

MME 5183: GEOMETRIC MODELING FOR CAD [3 1 0 4]

Hardware and software for Computer Aided Design (CAD), geometric modelling concepts of CAD; Mathematical representation in parametric form of analytic curves (line, circle, ellipse and hyperbola), synthetic curves (Hermite cubic splines, Bezier curves, B-spline curves, NURBS), analytical surfaces (plane, ruled, tabulated, revolved), synthetic surfaces (Bi-cubic, Bezier, B-spline, NURBS, Coons, Ferguson's and Bi-linear surface patches); Solid modeling techniques (Half spaces, Boundary representation, Constructive solid geometry, Sweep representation, Analytic solid modeling); rasterization of lines, circles and ellipse; 3D transformation (translation, scaling, rotation and concatenation) of geometric entities and their projections; principles of visual realism and mechanical assembly.

References:

1. Michael E. Mortenson, GEOMETRIC MODELING, Wiley Computer Publishing, John Wiley and Sons, Inc. (Second Edition), 1996.
2. Ibrahim K Zeid, *CAD/CAM Theory and Practice*, Tata McGraw Hill, New Delhi, 1998.
3. David F Rogers and J Alan Adams, *Mathematical Elements for Computer Graphics*, Tata McGraw Hill, New Delhi, 2002.
4. David F Rogers and J Alan Adams, *Procedural Elements for Computer Graphics*, McGraw Hill, New York, 2001.
5. Ram B, *Computer Fundamentals Architecture and Organization*, New Age International Ltd New Delhi, 2000.
6. Donald Hearn and M Pauline Baker, *Computer Graphics*, Prentice Hall of India, New Delhi, 2000.

MME 5184: SOLID MECHANICS [3 1 0 4]

Analysis of Stress: Deformable bodies, stress, strain, mechanical properties of solids, State of stress and stress components, Stresses on an arbitrary plane, Principal stresses, Octahedral stresses, Equations of equilibrium. Analysis of Strain: Deformation in the neighbourhood of a point, 3D strain components, Volumetric strain, Principal strains, Compatibility conditions. Stress-strain Relations: Generalized Hooke's law, Stress strain equations for isotropic materials, Young's modulus, modulus of rigidity, Bulk modulus. Theories of Failure: Maximum normal stress theory, maximum shear stress theory, maximum strain theory, maximum elastic energy theory, distortion energy theory, Factor of safety. Energy Methods: Hooke's Law and Principle of superposition, Corresponding forces and displacements, work done by forces and elastic strain energy, Reciprocal relations, Castigliano's theorems. Bending of Beams: Introduction, straight beams and axi-symmetrical bending, bending stresses. Axi-Symmetric Problems: Introduction, equilibrium equations, thick and thin cylinders.

References:

1. L.S. Srinath “Advanced Mechanics of Solids”, Tata Mcgraw Hill, 1980.
2. S.M.A. Kazmi “Solid Mechanics”, Tata Mcgraw Hill, 1980.
3. E.P. Popov “Introduction to Mechanics of solids”, Prentice Hall of India, Ltd, 1973.
4. Y.C.Fung “Foundations of solid mechanics”, Prentice Hall of India, 1968.
5. S.A.Urry and P.J.Turner “Solving problems in solid mechanics” – vol 1 and 2, Longman Scientific and technical U.K., 1986.
6. S.C.Goyal and M.R.Sethia “ Mechanics of solids”, Sandhya Prakashan – 1997.
7. N.Krishnaraja and D.R. Gururaja “Advanced Mechanics of solids and structures”, Narosa Publishing House, 1997.

MME 5161: CAD LAB [0 0 6 2]

Construct geometrically constrained 2D objects; develop solid models of machine parts; develop surface models of engineering applications; assemble solid models of parts into machine components; develop the product drawings (orthographic, sectional and pictorial/isometric views) of assembled machine components

References:

1. Sham Tickoo, *CATIA – for Engineers and Designers* Dreamtech Press New Delhi, 2008.

MME 5165 DESIGN ENGINEERING LAB [0 0 3 1]

Friction and wear performance tests; Journal bearing characteristics; Lubricity and viscosity measurement; Surface roughness measurement; Air bearing performance testing; Determination of natural frequency of single DOF undamped, damped and torsional vibrations systems; Determination of critical speed of shaft; Determination of center of percussion, mass moment of inertia of irregular bodies; Frequency response of single DOF viscous damped forced vibration system; Natural frequency of continuous system; Modelling of equivalent spring-mass system; Field balancing of rotor system; Fatigue test; Time domain, frequency domain, time-frequency domain analysis of specific signals acquired from machinery; Basic study of Atomic Force Microscopy (AFM) in imaging and material characterization.

References:

1. Kenneth C Ludema, Friction, Wear, Lubrication: A Textbook in Tribology, CRC press, 1996.
2. GwidonStachowiak, Andrew Batchelor, Engineering Tribology, Elsevier, 4th ed., 2013.
3. Singirisu Rao S., “Mechanical Vibration” Pearson Education, Delhi, 2004
4. S. Graham Kelly,“Fundamentals of Mechanical Vibrations”, McGraw-Hill, Singapore, 1993.
5. RudraPratap, “Getting Started with MATLAB”, Oxford University Press, USA

SEMESTER II

MME 5282: LUBRICATION OF BEARINGS [3 1 0 4]

Lubricants and their physical properties, lubricants standards, lubrication regimes, Hydrodynamic Lubrication Theory- Reynolds equation, Design of fluid film bearings, lubricant flow and delivery, Hydrodynamic instability. Elasto hydrodynamic lubrication, Hertzian stress equation, load capacity, stresses and deflection, bearing life calculation, rolling bearing failures. Computational hydrodynamics, Finite difference equivalent of the Reynolds equation, Numerical analysis of hydrodynamic lubrication in a real bearing. Hydrostatic lubrication: generalized approach to hydrostatic bearing analysis, Optimization of hydrostatic bearing design, Aerostatic bearings, Hybrid bearings, Stability of hydrostatic and aerostatic bearings. Solid lubrication: Lubrication by lamellar solids, Friction and wear characteristics of lamellar solids, Deposition methods of solid lubricants, Solid lubricants as additives to oils and polymers.

References:

1. Cameron A., *Basic Lubrication Theory*, Ellis Horwood Ltd, Chichester, 1983.
2. Majumdar B.C., *Introduction to Tribology of Bearings*, A H Wheeler & Co. Pvt. Ltd., Allahabad, 1999.
3. Williams J.A., *Engineering Tribology*, Cambridge University Press, UK, 2005.
4. Neale, M.J., *Tribology Hand Book*, Butterworth Heinemann, London, 1995.
5. Gwidon W. Stachowiak, Andrew W. Batchelor, *Engineering Tribology*, Butterworth Heinemann, London.

MME 5283: FINITE ELEMENT METHODS [3 1 0 4]

Introduction: General procedure of FEM. Formulation Methods - Direct Method: Spring and truss elements, arbitrarily oriented elements, transformation matrix, plane truss. Energy Method: Principle of total minimum potential energy, Formulation of plane stress/strain elements. Galerkin's Weighted Residual Method: Beam theory, formulation of beam element, arbitrarily oriented beam elements, plane frame. Isoparametric Elements: Formulation of truss, plane and solid elements. Introduction to Analysis Types: Modal or frequency analysis, thermal analysis, thermo-structural analysis, axi-symmetric analysis, fluid flow analysis.

References:

1. Daryl L Logan, A First Course in Finite Element Method, Thomson Asia Pvt. Ltd, Bangalore, 2002.
2. Akin J.E., Finite Element Analysis for Undergraduates, Academic Press, London, 1989.
3. Martin H.C. and Carey G.F., Introduction to Finite Element Analysis, Tata McGraw Hill, New Delhi, 1975.
4. Segerlind L J., Applied Finite Element Analysis, John Wiley, New York, 1984.
5. Bathe K J, Finite Element Procedures, Prentice Hall of India New Delhi, 2003.
6. Cook Robert D, Concepts and Applications of Finite Element Analysis, John Wiley and Sons New York, 2000.

MME 5262: FINITE ELEMENT ANALYSIS LAB [0 0 6 2]

Model and carry out structural analysis of plane/space trusses, plane/space frames, 2D components, 3D components, shells and contact problems using the GUI of a standard FEA software; Write Macros/codes for developing mapped mesh for 2D and 3D boundary value problems and analyze the same; Carry out the modal, harmonic and contact analysis of structural problems; Model and carry out 2D/3D thermal analysis and thermo-structural problems; Write and execute scripts/programs for analyzing 1D problems, plane/space trusses, plane/space frames and 2D structural problems.

References:

1. Eliahu Zahavi (1992) "The Finite Element Method in Machine Design" Prentice Hall Inc USA.
2. Ramamurthy V (1997) "Computer Aided Mechanical Design and Analysis" Tata Mcgraw Hill Delhi.
3. Daryl L Logan (2002) "A First Course in the Finite Element Method" Thomson Asia Pvt. Ltd. Bangalore.
4. Tirupathi R. Chandrupatla and Ashok D. Belegundu (2012), "Introduction to Finite Element Engineering" 4th Edition, Pearson.
5. Rudra Pratap, "Getting Started with MATLAB", Oxford University Press, USA

PROGRAM ELECTIVES

MME 5004: COMPUTATIONAL FLUID DYNAMICS [3 1 0 4]

Models of Flow and derivation of governing conservation differential equations for different models for conservation of mass, momentum and Energy. Discussion of characteristics and Boundary and Initial conditions. Basic numerical methods to solve first diffusion related flow physics followed by Convective dominated Diffusion flows. Difficulties and strategies to solve such flows.Algorithmic approach and convergence as well as stability. Turbulence and related closure using turbulence modelling.

References:

1. John D Anderson Jr. (1995). "Computational Fluid Dynamics- The Basics with Applications", International Edition, McGraw Hill, New York.
2. Suhas V. Patankar, (1980). "Numerical Heat Transfer and Fluid Flow", Hemisphere / McGraw Hill, New York.
3. H. K. Versteeg and W. Malalasekera. (1995) "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Longman Scientific & Technical. England
4. Ghoshdastidhar. (1998) "Computer Simulation of Flow and Heat Transfer", Tata- McGraw-Hill Book Company, New Delhi
5. K. Muralidhar and T. Sundararajan (2003), "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi

MME 5013: DESIGN FOR MANUFACTURING [3 1 0 4]

Significance of design for manufacturing (DFM), factors influencing design, Selection of materials, Selection of manufacturing processes, Design for assembly, Design for serviceability, DFM of formed metal components-metal extrusions, metal stampings, cold extruded parts, roll formed sections, powder metallurgy parts, forging, metal injection molded parts, DFM of castings-sand casting, investment casting, die casting, DFM of machined components-turning, drilling, reaming, boring, milling, slotting, grinding, honing, lapping, superfinishing, advanced machining processes, gears and non metallic parts, Process engineering-designing for heat treatment, Sequence of operations for manufacturing of round and flat type components, Manufacturing drawings-dimensioning for manufacturing, fits, tolerance and surface finish consideration in design, preparation of manufacturing drawings of components.

References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, *Product Design for Manufacture and Assembly,* (3e), CRC Press, 2011.
2. James G. Brala*, Design for Manufacturability Handbook,* (2e), McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood*, Product Design,* Pearson Education, Delhi, 2001.

4. Corrado Poli, *Design for Manufacturing: A Structured Approach,* Butterworth-Heinemann Ltd., 2001

MME 5014: FRACTURE MECHANICS [3 1 0 4]

Fracture mechanics approach to design, brittle and ductile fracture, effect of material properties on fracture. Linear Elastic Fracture Mechanics- fracture modes, fracture criteria, mechanisms of fracture & crack growth, griffith's analysis, energy release rate (G), elastic crack tip fields, stress intensity factor, Crack tip plasticity -Irwin approach, strip yield model, plastic zone shape and size, plane strain fracture toughness. Elastic-Plastic Fracture Mechanics - J-integral, HRR fields, J-controlled crack growth, Crack tip opening displacement. Fracture toughness testing of metals - K_{Ic} test, J_{Ic} measurement, determination of critical CTOD. Fatigue Fracture Mechanics - Fatigue crack growth, crack closure and fatigue threshold, crack growth behavior under variable amplitude loading, effect of overload, prediction of fatigue crack growth and & life of a structural component. Fail safety and damage tolerance - damage tolerance approach of failsafe design, fracture safe design of thick & thin pressure vessels, leak before break, dynamic fracture mechanics, mixed mode fracture initiation and growth, Applications of fracture mechanics to engineering design, FEA of cracks in solids.

References:

1. Anderson T. L., *Fracture Mechanics-Fundamentals and applications*, (3e), CRC Press, London, 2005.
2. Richard W Hertzberg, Richard P Vinci and Jason L Hertzberg, *Deformation and Fracture Mechanics of Engineering Materials,* (5e), John Wiley & Sons, 2012.
3. Broek D., *The Practical Use of Fracture Mechanics*, Springer Netherlands, 1989.
4. Prashant Kumar, *Elements of Fracture Mechanics*, McGraw Hill Education Private Limited, 2013.
5. Norman E Dowling, *Mechanical Behaviour of Materials,* (4e), Prentice Hall, 2012.

MME 5015: MECHANICS OF COMPOSITE MATERIALS [3 1 0 4]

Importance of composite materials, overview, significance and characteristics of composite material, applications and developments, types and classification, Manufacturing of different types of composite materials, quality inspection methods, micro and macro mechanics of fiber reinforced lamina and macro mechanics of composite laminate, testing of composite materials, analysis of laminated composite beams, damage prediction, theories of failures for composite materials.

References:

1. Mallick. P.K., *Fiber Reinforced Composites: Materials, Manufacturing and Design (3e)*, CRC Press, 2007
2. B. D. Agarwal, L.J. Broutman, K. Chandrashekhara, Analysis and performance of fiber composites, Wiely, 2012
3. Robert M. Jones, *Mechanics of Composite Materials (2e)*, Talylor & Francis, 2015
4. Michael W, Hyer, *Stress analysis of fiber Reinforced Composite Materials*, McGraw Hill Publication, 1998.
5. Kishan K. Chawla, Composite materials – Science and Engineering, Springer, 2012
6. F. L. Matthews, R. D. Rawlings, Composite materials: Engineering and Science, CRC Press, 2005

MME 5016: ADVANCED MECHANISMS AND DESIGN [3 1 0 4]

Planar, spherical & spatial mechanisms; Grashoff's law, practical considerations, transmission angle, toggle position, mobility analysis. Synthesis of mechanisms: Type, number & dimensional synthesis; function generation, path generation & body guidance, Chebychev spacing of precision points, two position synthesis of slider crank & crank rocker mechanism, cupler curve synthesis by graphical method, Freudenstein's equation, Bloch synthesis, synthesis of dwell mechanism, intermittent rotary motion, Cognate linkages, Optimum size of cam. Kinematic analysis: Position analysis, vector loop equations for four bar, slider crank, inverted slider crank, geared five bar & six bar linkages; analytical method & auxiliary point method for velocity & acceleration analysis. Path curvature theory: Fixed and moving centrodes, inflection points & inflection circles, Euler Savary equation, graphical constructions, cubic of stationary curvature. Dynamics of mechanisms: Static force analysis with friction, inertia force analysis, combined static & inertia force analysis, shaking force, kinetostatic analysis. Spatial mechanisms and Robotics: Introduction to spatial linkages, special mechanisms, position analysis of RGGR mechanism, Denavit hartenberg parameters, forward & inverse kinematics of robotic manipulators.

References:

1. John J Uicker Jr., Gordon R Pennock and Joseph E Shigley (2003) " Theory of Machines and Mechanisms" Oxford University Press, Delhi
2. Robert L Norton (1999) "Design of Machinery – An Introduction to Synthesis of and Analysis of Mechanisms & Machines" McGraw Hill, New York
3. George N Sandor and Arthur G Erdman (1988) "Advanced Mechanisms Design: Analysis & Synthesis - Volume 2" Prentice Hall of India, Delhi
4. Hamilton H Mabie and Charles F Reinholtz (1987) "Mechanisms and Dynamics of Machinery" John Wiley & Sons, New York

MME 5017: BIO MECHANICS [3 1 0 4]

Overview of biomechanics and related fields, Fundamentals of Newtonian mechanics and weightlessness, Static force applied to the musculoskeletal system, Basic theory of strength of mechanics for hard tissues with infinitesimal strain, Mechanical characteristics of bones and teeth, Fundamentals of viscoelastic theory, Viscoelasticity of soft tissues, Mechanical characteristics of skeletal muscles with active contraction, Fundamentals of continuum mechanics for soft tissues with large strain, Mechanics of cardiovascular system (physiological functions), Mechanics of cardiovascular system (aging and disease), Dynamic characteristics of living tissues with impact, Mechanical tests and finite element analyses for cells and tissues.

References

1. Duane Knudson, Fundamentals of Biomechanics, Springer 2nd ed., 2007
2. Nihat Ozkaya, Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, Springer India, 2nd ed., 2009.
3. Arthur Chapman, Biomechanical Analysis of Fundamental Human Movements, Human Kinetics Publishers, 2008.
4. Dominique G Poitout , Biomechanics and Biomaterials in orthopedics, Springer Verilog London, 2016.

MME 5018: ROTOR DYNAMICS [3 1 0 4]

Torsional vibration in rotating and reciprocating machinery - Modeling of rotating machinery shafting, transfer matrix analysis for free vibrations, transient response in torsional vibration, modeling of the reciprocating machine systems, free & forced vibrations, finite element analysis. Bending critical speeds of simple shafts - Whirling of an unbalanced elastic rotor, shafts with several discs, shafts with overhangs. Out of balance response of rotors with rigid supports, Rotors mounted on Fluid Film bearings. Gyroscopic effects - Gyroscopic of a spinning disc, synchronous whirl of an overhung rotor, nonsynchronous whirl, rotor system with a coupling, finite element method and whirl speed analysis. Stability and whirling of a shaft with dissimilar moments of area. Instability due to fluid film forces and hysteresis, Instability in torsional vibration, Balancing of rigid and flexible rotors.

References:

1. Rao J. S., *Rotor Dynamics*, New Age International (P) Ltd., New Delhi, 1996.
2. Agnieszka Muszynska, Rotordynamics, CRC Taylor & Francis, 2005.
3. Chong-Won Lee, Vibration Analysis of Rotors, Springer Science Business Media, 2012.
4. Krzysztof Czolczynski, Rotordynamics of Gas-Lubricated Journal Bearing Systems, Springer 2012.
5. Friswell M. I., Dynamics of Rotating Machines, Cambridge, 2010.

OPEN ELECTIVES

MME 5053: CORROSION SCIENCE [3 0 0 3]

Definition of corrosion, Importance of corrosion study, Costs of corrosion, Corrosion environments, Corrosion damage, Classification of corrosion, Factors influencing corrosion rate. Uniform corrosion, Galvanic or two metal corrosion, Crevice corrosion, Pitting corrosion, Inter-granular corrosion, Selective leaching, Erosion corrosion, Stress corrosion, Hydrogen damage. Corrosion testing, Purpose, Materials and specimens, Surface preparation, measuring and weighing, Exposure techniques, Duration, Planned interval tests, Aeration, Cleaning specimens after exposure, Standard expressions for Corrosion rate. Corrosion prevention, Materials selection – Metals and alloys, Metal purification, non-metallics, Change of environments – Changing the medium, Use of Inhibitors, Design improvements, Cathodic and anodic protection, Coatings – metallic coating, inorganic coating, organic coating, failure analysis. Corrosion Principles, Electrochemical theory of corrosion, Applications of thermodynamics to corrosion, Free energy, activation energy, Polarization of corrosion reactions, Activation polarization, Concentration polarization, Combined polarization, Pourbaix diagram (E/pH diagram) passivity, Corrosion rate measurements – Tafel extrapolation and Liner polarization techniques.

References:

1. Mars G. Fontana, *Corrosion Engineering*, Third edition Tata McGraw Hill, New Delhi.
2. Zaki Ahmed, Principles of Corrosion Engineering and Corrosion Control, Elsevier Science and Technology Books, 2006.
3. K. R. Trethewey and J. Chamberlain Longman, *Corrosion for students of science and engineering*, Scientific & Technical New York, USA.
4. Schweitzer Philip A, Fundamentals of Corrosion-Mechanisms, Causes and Preventive Methods, CRC Press, Tayler and Francis Group, Boca Raton, 2010.
5. Pierre R. Roberge, *Corrosion Engineering – Principles and practices*, Gulf publishing company.

MME 5054: CREATIVITY FOR PRODUCT DESIGN [3 0 0 3]

Introduction to Product Design - Product Design Process, design by innovation, creativity in design, strength considerations in product design. Tools for design: Information-based tools, Procedure-based tools, Quality Function Deployment, Taguchi technique for robust design, Design for Manufacture, Rapid prototyping; Embodiment design. Creative thinking - The five dimensions of creativity, synthesis, evolution, revolution, re-application and change, creative thinking tools for idea generation and problem solving, convergent and divergent, theory of inventive problem solving. Basic Probability concepts- Basic probability theory, Central Limit Theorem, probability mass function, cumulative distribution function, probability density function. Reliability of Components and Systems- reliability theory, reliability management, history of reliability engineering; reliability allocation, reliability testing.

References:

1. Ulrich Karl T. and Eppinger Steven D., *Product Design and Development*, McGraw Hill International Edition, 1999.
2. Rosenthal Stephen, *Effective Product Design and Development*, Business One Orwin Homewood, 1992.
3. Dieter, *Engineering Design*, McGraw Hill International Edition, 1990.
4. Day Ronald G., *Quality Function Deployment*, Tata McGraw Hill, 1990.
5. Goldenberg and Mazursky, *Creativity in Product Innovation*, Cambridge University Press, 1996.

MME 5055: DESIGN OF EXPERIMENTS [3 0 0 3]

Understanding basic design principles, Working in simple comparative experimental contexts, introduction to R language and its applications in DOE problems, Working with single factors or one-way ANOVA in completely randomized experimental design contexts, Implementing randomized blocks, Latin square designs and extensions of these, Understanding factorial design contexts, Working with two level, 2*k*, designs, Implementing confounding and blocking in 2*k* designs, Working with 2-level fractional factorial designs, Working with 3-level and mixed-level factorials and fractional factorial designs, Simple linear regression models, Understanding and implementing response surface methodologies, Understanding robust parameter designs, Working with random and mixed effects models, Design of computer experiments and the applications in industrial engineering problems.

References:

1. Montgomery, D. C. (2001), *Design and Analysis of Experiments,* John Wiley & Sons. Inc. ISBN: 0-471-31649-0.
2. Dean, A. M. and Voss, D. T. (1999), *Design and Analysis of Experiments (Springer text in Statistics),* Springer Science + Business Media, Inc. ISBN: 0-387-98561-1.
3. Box, G. E. P., Hunter, W. G., and Hunter, J. S. (1978), *Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building,* John Wiley & Sons. Inc. ISBN: 0-471-09315-7.
4. Diamond, W. J. (2001), *Practical Experiment Designs for Engineers and Scientists,* John Wiley & Sons. Inc. ISBN: 0-471-39054-2.
5. Jeff Wu, C. E. and Hamada, M. I. (2000), *Experiments: Planning, Analysis, and Parameter Design Optimization,* John Wiley & Sons. Inc. ISBN: 0-471-39054-2.

MME 5056: ENERGY STORAGE SYSTEMS [3 0 0 3]

Need for energy storage, Different modes of energy storage, Pumped hydro storage, Kinetic energy and compressed gas system, Flywheel storage, Compressed air energy storage, Electrical and magnetic energy storage, Capacitors, Electromagnets, Chemical energy storage, Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels, Hydrogen for energy storage, Solar ponds, Electrochemical, Magnetic and Electric Energy Storage Systems: Batteries, Primary, Secondary, Lithium, Solid-state and molten solvent batteries, Lead acid batteries, Nickel Cadmium Batteries, Advanced batteries, Superconducting Magnet Energy Storage (SMES) systems, Capacitor and Batteries, Comparison and application, Super capacitor, Electrochemical Double Layer Capacitor (EDLC),Sensible and Latent Heat Storage: SHS mediums, Stratified storage systems, Rock-bed storage systems, Thermal storage in buildings, Earth storage, Energy storage in aquifers, Heat storage in SHS systems, Aquifers storage, Phase Change Materials (PCMs),Selection criteria of PCMs, Solar thermal LHTES systems, Energy conservation through LHTES systems, LHTES systems in refrigeration and air-conditioning systems, Numerical heat transfer in melting and freezing process, Application of Energy Storage: Food preservation, Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries.

References:

1. Johannes Jensen Bent Squrensen, *Fundamentals of Energy Storage*, John Wiley, NY , 1984.
2. *IEE Energy Series*, Electro-chemical Power Sources.
3. Baader, W., Dohne, E., Brenndorfer, *Bio-gas in Theory and Practice*.
4. P.D.Dunn, *Renewable Energies*. Peter Peregrinus Ltd, London, United Kingdom, First Edition, 1986.
5. Ibrahim Dincer, *Thermal Energy Storage: Systems and Applications*, Wiley Publications, 2010.

MME 5057: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]

Industrial revolution; Milestones in the safety movement; Accidents & their effects; Cost of accidents; Theories of accident causation - Domino theory, Human factor theory, Accident/incident theory, Epidemiological theory, System theory, Industrial Hazards Ergonomic Hazards; Mechanical Hazards; Fall and impact hazards; Temperature hazards; National Safety Council India (NSCI) and Industrial Safety Acts: Introduction to NSCI; Mission and Vision; Milestones; Management; NSCI safety award schemes; Safety audits; Risk assessment; NSCI safety rating system; Hazard and operational (HAZOP) studies, Industrial Safety Analysis and Management, Preliminary hazard analysis; Detailed hazard analysis; Failure mode and effect analysis (FMEA); Human error analysis (HEA); Environmental Safety: Safety, health and environment.

References:

1. David L. Goetsch, *Occupational Safety and Health for Technologists*, *Engineers and Managers*, 5th Edition, Pearson-Prentice Hall, 2005.
2. Frank R. Spellman and Nancy E. Whiting, *The Handbook of Safety Engineering: Principles and Applications*, The Scarecrow Press Inc., 2010
3. Amit Kumar Gupta, *Industrial Safety and Environment*, Laxmi Publications (P) Ltd., 2006
4. National Safety Council India, "NSC," [Online].Available: http://nsc.org.in/.
5. Ministry of Labour and Employment, "*Ministry of Labour and Employment*," [Online]. Available: http://nsc.org.in/.

MME 5058: 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. Chasel Aquilino, *Productions and Operations Management*, Dreamtech latest edition.
2. Yasuhiro Monden , Toyoto *Production System -An integrated approach to Just in Time, Engineeringaild Management Press* - Institute of Industrial Engineers Norcross Georgia, 1983.
3. James P Womack - Daniel T Jones- and Daniel Roos, *The Machine that changed the World. The Story of Lean Production* - -Harper Perennial - edition published, 1991.
4. James Womack, *Lean Thinking* - ISBN 0743249275, 2003.
5. Richard Schourberger, *Japanese Manufacturing Techniques*. The Nine Hidden Lessons by simplicity - ASQC Press, 1991.

MME 5059: RENEWABLE ENERGY TECHNOLOGY [3 0 0 3]

Solar energy –Production and transfer of solar energy – Sun-Earth angles –Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation. Applications of Solar energy, Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels, Aerobic and anaerobic bio-conversion – Properties of biomass, Biogas plants– Design and operation, Wind energy – Principles of wind energy conversion – Site selection considerations –Wind power plant design – Types of wind power conversion systems – Operation, maintenance and economics, fuel cells, fuel cell power plant, Geothermal fields- Hot dry rock, Energy conversion technologies, Ocean thermal energy conversion, Wave and tidal energy: Scope and economics – Introduction to integrated energy systems.

References:

1. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994.
2. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
3. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
4. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
5. H.P. Garg, S.C. Mullick and A.K. Bhargava: Solar Thermal Energy Storage, 1985
6. K.M. Mittal: Non-conventional Energy Systems-Principles, Progress and Prospects, Wheeler Publications, 1997.

DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING, MIT Manipal

M.Tech. TRIBOLOGY AND MAINTENANCE

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5155	Applied Numerical Methods	3	1	0	4	MME 5253	Microstructure and Surface Characterization	3	1	0	4
I	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	MME 5254	Non Destructive Evaluation	3	1	0	4
I	MME 5155	Advanced Sensors and Condition Monitoring	3	1	0	4	MME ****	Elective I	3	1	0	4
I	MME 5156	Friction and Wear	3	1	0	4	MME ****	Elective II	3	1	0	4
I	MME 5153	Lubrication Engineering	3	1	0	4	MME ****	Elective III	3	1	0	4
I	MME 5154	Surface Engineering	3	1	0	4	*** ****	Open Elective	3	0	0	3
I	MME 5168	CAD Lab	0	0	6	2	MME 5261	Experimental Mechanics Lab	0	0	3	1
I	MME 5160	Tribology Lab	0	0	3	1	MME 5285	Finite Element Analysis Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**18**	**5**	**6**	**25**
II	THIRD AND FOURTH SEMESTER											
II	MME 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
MME 5001	Advanced Engineering Materials	MME 5006	Maintenance Engineering and Management
MME 5002	Advances in Tribology	MME 5007	Manufacturing and Materials
MME 5003	Bio Materials in Medical Applications	MME 5008	Solid Mechanics
MME 5004	Computational Fluid Dynamics	MME 5009	Tribology in Medical Applications
MME 5005	Finite Element Methods		

OPEN ELECTIVES			
MME 5053	Corrosion Science	MME 5057	Industrial Safety Engineering
MME 5054	Creativity for Product Design	MME 5058	Lean Manufacturing
MME 5055	Design of Experiments	MME 5059	Renewable Energy Technology
MME 5056	Energy Storage Systems		

SEMESTER I

MAT 5155 APPLIED NUMERICAL METHODS [3 1 0 4]

Interpolations, Numerical Differentiation and Integration, Solution of linear and nonlinear system of equations: direct methods and iterative methods, Eigen values & Eigen vectors using Power Method. Numerical Solution of Ordinary Differential Equations, Initial Value Problems: Single step methods. Multi step methods, Boundary Value Problems: Finite difference method. Numerical Solution of Partial Differential Equations, Elliptic P.D.E, Parabolic P.D.E, Hyperbolic P.D.E.

References:

1. Atkinson K. E., An Introduction to Numerical Analysis, Edn. 3, John Wiley and Sons,1989.
2. Carnahan, Luther and Wikes, Applied Numerical Methods, TMH, 1969.
3. Hilderband F.B., Introduction to Numerical Analysis, Edn. 5, Tata McGraw Hill, New Delhi.
4. Conte S.D and Be Door, Introduction to Numerical analysis, McGraw Hill.
5. Gerald C.F. and Patrick D. Wheatley, Applied Numerical Analysis, Edn. 3, Addison Wesley, 1984.
6. Thomas J. W., Numerical Partial Differential Equations: Finite Difference Methods, Springer.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004.
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology, Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain&Cox, Experimental Designs, Edn.3.Wiley Publishers, 2006.

MME 5155 ADVANCED SENSORS AND CONDITION MONITORING [3 1 0 4]

Maintenance philosophies, Condition monitoring procedure and system integration, Thick Film sensing and system design, Design and manufacture of thick film devices, MEMS devices Common micro-fabrication techniques, Applications of MEMS in sensing systems, Overview of microfluidics, Energy harvesting and wireless networks, Ultrasonic Sensing systems, Advanced signal processing techniques, Time domain analysis, Frequency domain analysis, Time-frequency analysis, Artificial intelligence technologies, Condition monitoring techniques, Visual, Performance, Fluid and Vibration based techniques, Vibration data collection, Acoustic emission, Thermal techniques, Oil debris analysis, Strain sensing.

References

1. John Turner and Martyn Hill, Instrumentation for Engineers and Scientists, Oxford Science Publications, 1999.
2. M J Usher, Sensors and Transducers, MacMillan, 1985.
3. R.C. Asher Ultrasonic Sensors, IOP Publishing, 1997.
4. Kovacs, Gregory T. A. Micro machined transducers source book : WCB, Boston, Ma. 1998.
5. Peter J. Tavner, James Penman, Condition Monitoring of Electrical Machines, RSP Ltd., 1987.
6. Collacot R.A.- Mechanical fault diagnosis and condition monitoring, Chapman and Hall London, 1977.
7. Rao, B., Handbook of condition monitoring, Elsevier advanced technology, Oxford, 1996.

MME 5156 FRICTION AND WEAR [3 1 0 4]

Surface interactions, experimental study of surfaces and interfaces, measurements of geometry of surface interactions, size of junctions. Friction – types and characteristics, Measurement of friction, Adhesive wear, Abrasive wear, Corrosive wear, Fatigue wear, Brittle fracture wear, Impact wear, Erosive wear. Lubrication: Hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, solid film lubrication, boundary lubrication – single penetration and multiple penetration models. Effectiveness of liquid lubricant and solid lubricant. Process and products for wear reduction: Rebuilding and surfacing cements, wear tiles, electro spark deposition coatings, fused carbide cloth, thermal/chemical deposited ceramic coatings, centrifugal cast wear coatings, wear sleeves, wear plates.

References

1. Rabinowicz. E, Friction and Wear of Materials, John Wiley & Sons, Inc., 1995.
2. Bharat Bhushan, Principles and applications of Tribology, John Wiley & Sons Inc., 1999.
3. Arnell R. D., Davies P. B., Halling J. & Whomes T. L., Tribology: Principles and design applications, Macmillan Education Ltd. 1991.
4. Kenneth G. Budinski, Surface Engineering for wear resistance, Englewood Cliffs, New Jersey, 1988.

MME 5153 LUBRICATION ENGINEERING [3 1 0 4]

Bearing concepts and typical applications. Viscous flow concepts, Order of magnitude analysis, General Reynolds equation-2D and 3D (Cartesian and Cylindrical), Various mechanisms of pressure development in an oil film, Performance parameters. Boundary Layer Concepts in bearings, Mathematical modeling of flow in high-speed bearings. Elastic Deformation of bearing surfaces, Methods to avoid singularity effects, Estimation of elastic deformation by numerical methods, Governing equation for evaluation of film thickness in Elasto Hydrodynamic Lubrication (EHL) and its solution, Boundary conditions, Development of computer programs for mathematical modeling.

References

1. Bharat Bhushan, Principles and Applications of Tribology, Wiley, 2nd ed., 2013.
2. Mujumdar B. C., Introduction to Tribology of bearings, S. Chand Publishing, 1999.
3. Fuller D. D., Theory and Practice of Lubrication for Engineers, Wiley, 1984.
4. Bhushan B., Gupta B. K., Handbook of Tribology: Material, Coatings and Surface Treatments, Krieger Pub Co, 1997.
5. Davis J., Surface Engineering for Corrosion and Wear Resistance, Woodhead Publishing, 2001.
6. Tadausz Burakowski, Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipments and Technologies, CRC Press, 1998.

MME 5154 SURFACE ENGINEERING [3 1 0 4]

Surface engineering processes: Erosion resistant coatings deposited by Chemical Vapor Deposition, Physical Vapor Deposition, High Velocity Oxy-Fuel (thermal spray), and weld overlay. Plating and nano-composite coatings/surfaces. Corrosion resistant surfaces/high temperature. Surface modification: induction hardening, ion-implantation, carburizing, carbo-nitriding, nitriding and nitro-carburizing. Applications in marine, oil and gas, power generation, aerospace and biomedical sectors. Engineering assessment of each failure problem and the associated micromechanical failure modes, Economics of surface selection.

References

1. W.D. Callister, Materials Science and Engineering, an Introduction, (Sixth edition), Wiley, 2003.
2. K. L. Johnson, Contact Mechanics, (first edition), Cambridge University Press, 1996,
3. M. Cartier, Handbook of Surface Treatments and Coatings, Tribology in Practice series, Series editors: M.J. Neale, T.A. Polak and M. Priest, Engineering Professional Publishing, 2003
4. B.G. Mellor (ed.), Surface Coatings for Protection against Wear, Woodhead Publishing, 2006,
5. G.W. Stachowiak, Engineering Tribology, 3rd edition, Elsevier / Butterworth-Heinemann, 2005

MME 5168 CAD LAB [0 0 6 2]

Construct geometrically constrained 2D objects; develop solid models of machine parts; develop surface models of engineering applications; assemble solid models of parts into machine components; develop the product drawings (orthographic, sectional and pictorial/isometric views) of assembled machine components

References:

1. Sham Tickoo, CATIA – for Engineers and Designers Dreamtech Press New Delhi, 2008.

MME 5160 TRIBOLOGY LAB [0 0 3 1]

Friction and wear performance tests, Bearing friction measurement, Experiments on two body (sliding wear), Experiments on three body(abrasive wear), Lubricity tests– Variety of lubricants & greases, Air bearing rig, Viscometer(brook field rheo meter), Surface roughness measuring using – Talysurf & Interferometer, BioTribometer (Single Station, Programmable Pin Rotation), Scratch Tester Acoustic Emission.

References:

1. Kenneth C Ludema, Friction, Wear, Lubrication: A Textbook in Tribology, CRC press, 1996.
2. Gwidon Stachowiak, Andrew Batchelor, Engineering Tribology, Elsevier, 4th ed., 2013.

SEMESTER II

MME 5253 MICROSTRUCTURE AND SURFACE CHARACTERIZATION [3 1 0 4]

Surface Optical Profilometry, Atomic Force Microscopy and Surface Chemical Analysis, Nano indentation, Scanning Electron Microscopy, Focused Ion Beam Microscopy, Transmission Electron Microscopy, Energy Dispersive Spectroscopy, X-ray photoelectron Spectroscopy, Crystallography, X-ray diffraction and Electron diffraction, Electron Backscatter Diffraction, 3D techniques: 3DAP, Tomography, scientific report analysis, Case studies on microstructural and surface characteristics changes and its influence on tribology.

References

1. P. J. Goodhew, F.J. Humphreys and R. Beanland, Electron Microscopy and Analysis, 3rd ed., Taylor and Francis, London, 2000.
2. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic, 2nd ed., Wiley-Verlag, GmbH, 2013.
3. David Brandon, Wayne D. Kaplan, Microstructural Characterization of Materials, 2nd ed., Wiley, England, 2008.
4. Sam Zhang, Lin Li and Ashok Kumar, Taylor and Francis Group, Boca Raton, 2013.
5. Ludwig Reimer, Scanning Electron Microscopy: Physics of Image Formation and Microanalysis, Springer-Verlag, Berlin, GmbH, 1985.

MME 5254 NON DESTRUCTIVE EVALUATION [3 1 0 4]

NDE in design, manufacturing and maintenance, mechanical failure modes, NDE techniques, case study of applications of NDT for damage inspection/detection and characterization, process monitoring, structural monitoring, fatigue monitoring, monitoring of manufacturing processes covering major application areas such as aerospace, nuclear, automobile and marine industries. NDE codes, specifications and standards.

References

1. Don E bray, Roderic K Stanley, Nondestructive Evaluation: A tool in design, manufacturing and service, Taylor and Francis group London, Rev. ed., 1997.
2. Paul E Mix, Introduction to Nondestructive Testing-A training Guide, Wiley, 2nd Ed., 2005.
3. NDT Hand books, American Society for Nondestructive Testing (ASNT), USA, 4th ed., Vol. 1 – 10, 2017.
4. Davis Joseph R., ASM Handbook: Nondestructive Evaluation and Quality Control Volume 17, ASM International Materials, 1989.
5. Baldev Raj, Jayakumar T, Thavasimuthu, Practical Non-Destructive Testing, Narosa Publishing House, New Delhi, 1997.
6. Mcgonnagle W J., Physics and Nondestructive Testing, Golden and Breach, New York, 1969.

MME 5261 EXPERIMENTAL MECHANICS LAB [0 0 3 1]

Tensile tests, Flexural tests, Torsion test, Hardness tests, Photoelastic stress analysis equipment, Experiments on cantilever beam, Vibration monitoring experiments, Balancing instrumentation, Electronic strain gauges &Piezoelectric, Fatigue test, SEM, EDS, XRD, AFM (demo)

References:

1. Albert S. Kobayashi, Handbook on Experimental Mechanics, Prentice Hall, 1987.
2. Cesar A. Sciammarella, Federico M. Sciammarella, Experimental Mechanics of Solids, Wiley, 2012.

MME 5285 FEA Lab [0 0 3 1]

Model and carry out structural analysis of plane/space trusses, plane/space frames, 2D, 3D, shells and contact problems using the GUI of a standard FEA software; Write Macros/codes for developing mapped mesh for 2D and 3D boundary value problems and analyze the same; Carry out the modal, harmonic and contact analysis of structural problems; Model and carry out 2D/3D thermal analysis and thermo-structural problems; Write and execute scripts/programs for analyzing 1D problems, plane/space trusses, plane/space frames and 2D structural problems.

References:

1. Eliahu Zahavi (1992) “The Finite Element Method in Machine Design” Prentice Hall Inc USA.
2. Ramamurthy V (1997) “Computer Aided Mechanical Design and Analysis” Tata Mcgraw Hill Delhi.
3. Daryl L Logan (2002) “A First Course in the Finite Element Method” Thomson Asia Pvt. Ltd. Bangalore.
4. Rudra Pratap, “Getting Started with MATLAB”, Oxford University Press, USA

PROGRAM ELECTIVES

MME 5001 ADVANCED ENGINEERING MATERIALS [3 1 0 4]

Materials Selection for Design, Material lifecycle, Manufacturing waste, Recycling, Sustainability and environment. Aluminium alloys and strengthening theory: relations between microstructure and properties of metallic alloys, Micro mechanisms of strengthening and deformation, Aluminium alloys, Metal Matrix Composites, Automotive and Aerospace Al alloys, Titanium alloys, Alloy processing, applications, Nickel based superalloys, Ceramics, Intermetallics, Hybrid materials, Structural glasses, Materials in automotive applications.

References

1. Michael F. Ashby, Materials Selection in Mechanical Design, 4th ed., 2010,
2. Ian J. Polmear, Light Alloys, Elsevier, 4th ed., 2005
3. D. R. Askeland, The Science and Engineering of Materials, Chapman and Hall, 6th ed., 2010.

MME 5002 ADVANCES IN TRIBOLOGY [3 1 0 4]

Multiscale nature of tribology, Bio tribology, Physics of tribology, Mechanical properties of solids and thermodynamics, Atomistic origins of friction, Physics and mechanisms of wear: Physics of surface-Surface energy and capillary pressure, Zisman method, Derjaguin approximation, dry environment, force between a sphere and a flat, Johnson-Kendall-Roberts theory, Derjaguin-Muller-Topov theory, Hamaker constant, Surface energies arising from Van der Waals interactions, Principles of modelling, Modelling of contact, Modelling of friction, Admonton's law, Coulomb's law, Frenkel-Kontorova model, Tomlinson model, Modelling of lubrication, Modelling of wear, Archard's law. Modelling of adhesion and surface forces, Computational techniques, Atomistic and first-principles techniques, Hartree-Fock method and applications, Molecular dynamics techniques.

References

1. Bhushan, B., Nanotribology and Nanomechanics, Springer, 2004.
2. Dowson D, Biotribology (Tribology in Practice Series), Wiley-Blackwell, 2011.
3. Mow VC, Huiskes R., Basic Orthopaedic Biomechanics and Mechano-Biology, 2005.
4. Ratner B.D., Hoffman A.S., Schoen F.J., Lemons J.E., Biomaterials science: an introduction to materials in medicine. 3rd Edition. Elsevier Academic Press, 2012.
5. Chung Y-W, Micro- and Nano-scale Phenomena in Tribology, CRC Press, 2012.
6. Ethier, C. Ross and Simmons, Craig A., Introductory Biomechanics: From Cells to Organisms, Cambridge University Press; 1st ed., 2007.

MME 5003 BIO MATERIALS IN MEDICAL APPLICATIONS [3 1 0 4]

Material science and Engineering - Properties of materials, Classes of materials used in medicine – metals, polymers, ceramics, composites, testing biomaterials, Implant materials – metallic, ceramic, polymeric, composite, Natural Bone and Tooth: Structure and Properties, Processing of Implant Biomaterials, Fundamentals of Scaffolds Fabrication Using Low temperature Additive Manufacturing, Mechanical Properties of Biomaterials, Friction and Wear Behavior, Corrosion and Degradation of Implantable Biomaterials, Probing Toxicity of Biomaterials and Biocompatibility Assessment, Introduction to Biomechanics and Orthopedic Device Testing, Innovative Design of Biomaterials-Functionally Graded Implants

References:

1. B. Basu, Biomaterials for Musculoskeletal Regeneration, Springer Nature Singapore Pte Ltd, 2017.
2. M. F. Refojo, Application of Materials in Medicine and Dentistry: Ophthalmologic Applications, 1996.
3. J. Park and R. S. Lakes, Biomaterials, Springer-Verlag New York, 2007.
4. Joon Bu Park, Biomaterials Science & Engineering, Springer US, 1984.
5. P. Stoyanov and R. R. Chromik, Scaling effects on materials tribology: From macro to micro scale, Materials (Basel), vol. 10, no. 5, 2017.
6. Kulinets, Biomaterials & their applications in medicine, Elsevier, 2015.

MME 5004 COMPUTATIONAL FLUID DYNAMICS [3 1 0 4]

Governing Equations, General Characteristic of the governing equations, Discretization Process- concept and structure, Explicit Taylor series expansion, The Basic Solution Techniques, Explicit, Implicit and Crank Nicholson Methods, ADI Methods, Discretization using Control Volume technique, CDS, Upwind and Exact schemes, Properties of discretization schemes, Boundary Conditions. Turbulence modeling, Effect of turbulence.

References

1. John D Anderson Jr., “Computational Fluid Dynamics-The Basics with Applications”. International Edition. McGraw Hill. New York, 1995.
2. Suhas V Patankar, “Numerical Heat Transfer and Fluid Flow”. - Hemisphere / McGraw Hill. New York, 1980.
3. H.K. Versteeg and W. Malalasekera, “An Introduction to Computational Fluid Dynamics.- The Finite Volume Method”.- Longman Scientific & Technical. England, 1995.
4. K.Muralidhar and T.Sundararajan, ”Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2003

MME 5005 FINITE ELEMENT METHODS [3 1 0 4]

Introduction, Direct Stiffness Method, Element shape function and stiffness matrix, Assembly of elements, Essential boundary conditions and solving, Transformation, Formulation and solution, Potential energy of a deformable structure, Total potential energy and stationary property, Galerkin's residual method, Plane stress and plane strain stiffness equations, Constant strain triangular element stiffness matrix, Higher order elements, Transformation, Isoparametric formulation of element stiffness matrix, Evaluation of stiffness matrix by Gaussian quadrature, Hexahedral and Tetrahedral elements and their shape functions, Application of FEM to heat transfer and fluid flow.

References

1. Daryl L Logan, A First Course in Finite Element Method, Thomson Asia Pvt. Ltd, Bangalore, 2002.
2. Bathe K J, Finite Element Procedures, Prentice Hall of India, 2003.
3. Martin H C, Carey G F, Introduction to Finite Element Analysis, Tata McGraw Hill, 1975.
4. Zienkeiwicz O C, Taylor R L, Finite Element Method for solid and structural mechanics, Elsevier London, 2006.

MME 5006 MAINTENANCE ENGINEERING AND MANAGEMENT [3 1 0 4]

Maintenance – Key to reliability & productivity. Basic elements of maintenance system – inspection, planning & scheduling, job execution, record keeping, data analysis, learning & improvement. Introduction to computer-aided maintenance management system. Maintenance. Management Relevance of maintenance, maintenance: an over view, maintenance services, problems of the plant manager, automation and maintenance, maintenance objectives and costs, quality and quality circle in maintenance, Engineering reliability, maintainability Maintenance Types/systems Planned and unplanned maintenance, breakdown, corrective, opportunistic, routine, preventive, predictive, CBM, Design out maintenance

References:

1. H.P.Garg, Industrial Maintenance , S. Chand Publishing, 2010.
2. S.K. Srivastava: Industrial Maintenance Management, S.Chand & Co, New Delhi, 1998
3. Mishra, R. C. and Pathak, K., Maintenance Engineering and Management, 2nd ed., Prentice Hall of India, New Delhi, 2004.
4. Dhillon B.S., Engineering Maintenance: A Modern Approach, Taylor & Francis Group, 2002.
5. Mobley R. K., An Introduction to Predictive Maintenance, Second Edition, Butterworth-Heinemann, 2002
6. Scheffer C. and Girdhar P., Machinery Vibration Analysis & Predictive Maintenance, IDC Technologies, 2004.

MME 5007 MANUFACTURING AND MATERIALS [3 1 0 4]

Manufacturing process selection for design, Performance factors, Casting Processes, Joining Processes, Welding process, Metal forming Processes, Sheet metal deformation processes, Powder processing. Machining and Cutting Processes, Single and multiple point cutting processes and performance parameters, Tool materials and the economics of tool wear. Manufacturing processes for polymers and composites. Additive Manufacturing/3D printing, Micro and Nano fabrication, MEMS, Silicon materials and other functional materials, and their processing methods.

References

1. L Edwards, M Endean, Manufacturing with Materials, Butterworth Heinemann, 1990.
2. S. Kalpakjian and S.R. Schmid, Manufacturing Engineering and Technology, 5th ed., Prentice Hall, Singapore, 2009.
3. M. P. Groover, Fundamentals of Modern Manufacturing, Materials, Processes and Systems, Wiley, 3rd ed., Wiley, 2010.
4. C.K. Chua, K.F. Leong, C.S. Lim, Rapid prototyping: principles and applications, World Scientific, 3rd ed., 2010.
5. Sanjay Mazumdar, Composites Manufacturing: Materials, Product, and Process Engineering, CRC Press, 2001.

MME 5008 SOLID MECHANICS [3 1 0 4]

Analysis of stresses – Cauchy's stress formula, Principal stresses, Mohr's circle for 3D state of stress, Octahedral stresses, Equations of equilibrium. Analysis of strain – 3D state of strain, volumetric strain, Principal strains, Compatibility conditions. Stress- strain relations- Generalized Hooke's law, Elastic constants, Displacement equations of equilibrium. Theories of failure. Energy methods, Bending of beams, Axisymmetric problems – Stresses in composite tubes, Stresses due to gravitation, Rotating disc, Shafts and Cylinders.

References

1. L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, 2009.
2. S.M.A. Kazmi, Solid Mechanics, Tata McGraw Hill, 2nd Rev. ed., 2017.
3. Stephen H Crandall, Norman C Dahl, Thomas J Lardner, An Introduction to Mechanics of Solids, Tata McGraw Hill, 2009.

MME 5009 TRIBOLOGY IN MEDICAL APPLICATIONS [3 1 0 4]

Introduction to Bio tribology, Adhesion and Non-adhesive surfaces, Surface topography and its imaging technique, Gait analysis and Contact mechanics of articular joints, Friction and wear mechanism in implant interface, Surface texture and coating on implant substrate, Synovial fluid: function and properties, Tribology of natural diarthrodial joint, Hip and knee simulator, Knee and hip implant: scope and challenges, Designing of artificial hip and knee joints, Surface modification of joint prosthesis, Experimental and computer simulation of artificial hip and knee joints, Wear debris: mechanical and biological rules in relation to joint prostheses

References

1. J Paulo Davim, Biomaterials and Medical Tribology, Woodhead Publishing, 1st ed., 2013.
2. J Paulo Davim, Tribology for engineers - A practical guide, Woodhead Publishing, 2011 Zhong-Rong Zhou.
3. Hai-Yang Yu, Dental Bio tribology, Springer, 2013.
4. Zhongmin Jin , Computational Modelling of Biomechanics and Bio tribology in the Musculoskeletal System, Elsevier, 2014.
5. Duncan Dowson, Advances in Medical Tribology Orthopedic Implants and Implant Material, Wiley, 1st ed., 1997.

OPEN ELECTIVES

MME 5053: CORROSION SCIENCE [3 0 0 3]

Definition of corrosion, Importance of corrosion study, Costs of corrosion, Corrosion environments, Corrosion damage, Classification of corrosion, Factors influencing corrosion rate. Uniform corrosion, Galvanic or two metal corrosion, Crevice corrosion, Pitting corrosion, Inter-granular corrosion, Selective leaching, Erosion corrosion, Stress corrosion, Hydrogen damage. Corrosion testing, Purpose, Materials and specimens, Surface preparation, measuring and weighing, Exposure techniques, Duration, Planned interval tests, Aeration, Cleaning specimens after exposure, Standard expressions for Corrosion rate. Corrosion prevention, Materials selection – Metals and alloys, Metal purification, non-metallics, Change of environments – Changing the medium, Use of Inhibitors, Design improvements, Cathodic and anodic protection, Coatings – metallic coating, inorganic coating, organic coating, failure analysis. Corrosion Principles, Electrochemical theory of corrosion, Applications of thermodynamics to corrosion, Free energy, activation energy, Polarization of corrosion reactions, Activation polarization, Concentration polarization, Combined polarization, Pourbaix diagram (E/pH diagram) passivity, Corrosion rate measurements – Tafel extrapolation and Liner polarization techniques.

References:

1. Mars G. Fontana, *Corrosion Engineering*, Third edition Tata McGraw Hill, New Delhi.
2. Zaki Ahmed, Principles of Corrosion Engineering and Corrosion Control, Elsevier Science and Technology Books, 2006.
3. K. R. Trethewey and J. Chamberlain Longman, *Corrosion for students of science and engineering*, Scientific & Technical New York, USA.
4. Schweitzer Philip A, Fundamentals of Corrosion-Mechanisms, Causes and Preventive Methods, CRC Press, Tayler and Francis Group, Boca Raton, 2010.
5. Pierre R. Roberge, *Corrosion Engineering – Principles and practices*, Gulf publishing company.

MME 5054: CREATIVITY FOR PRODUCT DESIGN [3 0 0 3]

Introduction to Product Design - Product Design Process, design by innovation, creativity in design, strength considerations in product design. Tools for design: Information-based tools, Procedure-based tools, Quality Function Deployment, Taguchi technique for robust design, Design for Manufacture, Rapid prototyping; Embodiment design. Creative thinking - The five dimensions of creativity, synthesis, evolution, revolution, re-application and change, creative thinking tools for idea generation and problem solving, convergent and divergent, theory of inventive problem solving. Basic Probability concepts- Basic probability theory, Central Limit Theorem, probability mass function, cumulative distribution function, probability density function. Reliability of Components and Systems- reliability theory, reliability management, history of reliability engineering; reliability allocation, reliability testing.

References:

1. Ulrich Karl T. and Eppinger Steven D., *Product Design and Development*, McGraw Hill International Edition, 1999.
2. Rosenthal Stephen, *Effective Product Design and Development*, Business One Orwin Homewood, 1992.
3. Dieter, *Engineering Design*, McGraw Hill International Edition, 1990.
4. Day Ronald G., *Quality Function Deployment*, Tata McGraw Hill, 1990.
5. Goldenberg and Mazursky, *Creativity in Product Innovation*, Cambridge University Press, 1996.

MME 5055: DESIGN OF EXPERIMENTS [3 0 0 3]

Understanding basic design principles, Working in simple comparative experimental contexts, introduction to R language and its applications in DOE problems, Working with single factors or one-way ANOVA in completely randomized experimental design contexts, Implementing randomized blocks, Latin square designs and extensions of these, Understanding factorial design contexts, Working with two level, 2*k*, designs, Implementing confounding and blocking in 2*k* designs, Working with 2-level fractional factorial designs, Working with 3-level and mixed-level factorials and fractional factorial designs, Simple linear regression models, Understanding and implementing response surface methodologies, Understanding robust parameter designs, Working with random and mixed effects models, Design of computer experiments and the applications in industrial engineering problems.

References:

1. Montgomery, D. C. (2001), *Design and Analysis of Experiments,* John Wiley & Sons. Inc. ISBN: 0-471-31649-0.
2. Dean, A. M. and Voss, D. T. (1999), *Design and Analysis of Experiments (Springer text in Statistics),* Springer Science + Business Media, Inc. ISBN: 0-387-98561-1.
3. Box, G. E. P., Hunter, W. G., and Hunter, J. S. (1978), *Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building,* John Wiley & Sons. Inc. ISBN: 0-471-09315-7.
4. Diamond, W. J. (2001), *Practical Experiment Designs for Engineers and Scientists,* John Wiley & Sons. Inc. ISBN: 0-471-39054-2.
5. Jeff Wu, C. E. and Hamada, M. I. (2000), *Experiments: Planning, Analysis, and Parameter Design Optimization,* John Wiley & Sons. Inc. ISBN: 0-471-39054-2.

MME 5056: ENERGY STORAGE SYSTEMS [3 0 0 3]

Need for energy storage, Different modes of energy storage, Pumped hydro storage, Kinetic energy and compressed gas system, Flywheel storage, Compressed air energy storage, Electrical and magnetic energy storage, Capacitors, Electromagnets, Chemical energy storage, Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels, Hydrogen for energy storage, Solar ponds, Electrochemical, Magnetic and Electric Energy Storage Systems: Batteries, Primary, Secondary, Lithium, Solid-state and molten solvent batteries, Lead acid batteries, Nickel Cadmium Batteries, Advanced batteries, Superconducting Magnet Energy Storage (SMES) systems, Capacitor and Batteries, Comparison and application, Super capacitor, Electrochemical Double Layer Capacitor (EDLC),Sensible and Latent Heat Storage: SHS mediums, Stratified storage systems, Rock-bed storage systems, Thermal storage in buildings, Earth storage, Energy storage in aquifers, Heat storage in SHS systems, Aquifers storage, Phase Change Materials (PCMs),Selection criteria of PCMs, Solar thermal LHTES systems, Energy conservation through LHTES systems, LHTES systems in refrigeration and air-conditioning systems, Numerical heat transfer in melting and freezing process, Application of Energy Storage: Food preservation, Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries.

References:

1. Johannes Jensen Bent Squrensen, *Fundamentals of Energy Storage*, John Wiley, NY , 1984.
2. *IEE Energy Series*, Electro-chemical Power Sources.
3. Baader, W., Dohne, E., Brenndorfer, *Bio-gas in Theory and Practice*.
4. P.D.Dunn, *Renewable Energies*. Peter Peregrinus Ltd, London, United Kingdom, First Edition, 1986.
5. Ibrahim Dincer, *Thermal Energy Storage: Systems and Applications*, Wiley Publications, 2010.

MME 5057: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]

Industrial revolution; Milestones in the safety movement; Accidents & their effects; Cost of accidents; Theories of accident causation - Domino theory, Human factor theory, Accident/incident theory, Epidemiological theory, System theory, Industrial Hazards Ergonomic Hazards; Mechanical Hazards; Fall and impact hazards; Temperature hazards; National Safety Council India (NSCI) and Industrial Safety Acts: Introduction to NSCI; Mission and Vision; Milestones; Management; NSCI safety award schemes; Safety audits; Risk assessment; NSCI safety rating system; Hazard and operational (HAZOP) studies, Industrial Safety Analysis and Management, Preliminary hazard analysis; Detailed hazard analysis; Failure mode and effect analysis (FMEA); Human error analysis (HEA); Environmental Safety: Safety, health and environment.

References:

1. David L. Goetsch, *Occupational Safety and Health for Technologists*, *Engineers and Managers*, 5th Edition, Pearson-Prentice Hall, 2005.
2. Frank R. Spellman and Nancy E. Whiting, *The Handbook of Safety Engineering: Principles and Applications*, The Scarecrow Press Inc., 2010

3. Amit Kumar Gupta, *Industrial Safety and Environment*, Laxmi Publications (P) Ltd., 2006
4. National Safety Council India, "NSC," [Online].Available: http://nsc.org.in/.
5. Ministry of Labour and Employment, "*Ministry of Labour and Employment*," [Online]. Available: http://nsc.org.in/.

MME 5058: 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. Chasel Aquilino, *Productions and Operations Management*, Dreamtech latest edition.
2. Yasuhiro Monden , Toyoto *Production System -An integrated approach to Just in Time, Engineeringaild Management Press* - Institute of Industrial Engineers Norcross Georgia, 1983.
3. James P Womack - Daniel T Jones- and Daniel Roos, *The Machine that changed the World. The Story of Lean Production* - -Harper Perennial - edition published, 1991.
4. James Womack, *Lean Thinking* - ISBN 0743249275, 2003.
5. Richard Schourberger, *Japanese Manufacturing Techniques*. The Nine Hidden Lessons by simplicity - ASQC Press, 1991.

MME 5059: RENEWABLE ENERGY TECHNOLOGY [3 0 0 3]

Solar energy –Production and transfer of solar energy – Sun-Earth angles –Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation. Applications of Solar energy, Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels, Aerobic and anaerobic bio-conversion – Properties of biomass, Biogas plants– Design and operation, Wind energy – Principles of wind energy conversion – Site selection considerations –Wind power plant design – Types of wind power conversion systems – Operation, maintenance and economics, fuel cells, fuel cell power plant, Geothermal fields- Hot dry rock, Energy conversion technologies, Ocean thermal energy conversion, Wave and tidal energy: Scope and economics – Introduction to integrated energy systems.

References:

1. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994.
2. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
3. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
4. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
5. H.P. Garg, S.C. Mullick and A.K. Bhargava: Solar Thermal Energy Storage, 1985
6. K.M. Mittal: Non-conventional Energy Systems-Principles, Progress and Prospects, Wheeler Publications, 1997.

DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING, MIT Manipal

M.Tech. THERMAL SCIENCES & ENERGY SYSTEMS

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5155	Applied Numerical Methods	3	1	0	4	MME 5291	Computational Fluid Dynamics	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	MME 5292	Energy Management, Conservation and Storage	3	1	0	4
	MME 5191	Advanced Fluid Dynamics	3	1	0	4	MME ****	Elective I	3	1	0	4
	MME 5192	Design of Thermal Systems	3	1	0	4	MME ****	Elective II	3	1	0	4
	MME 5193	FEM for Thermal Engineering	3	1	0	4	MME ****	Elective III	3	1	0	4
	MME 5194	Solar Thermal Energy Systems	3	1	0	4	*** ****	Open Elective	3	0	0	3
	MME 5166	FEA Lab on Thermal Systems	0	0	6	2	MME 5269	CFD Lab	0	0	3	1
	MME 5167	Thermal Lab	0	0	3	1	MME 5265	Renewable Energy Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**18**	**5**	**6**	**25**
II	**THIRD AND FOURTH SEMESTER**											
	MME 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
MME 5019	Advanced Heat Transfer	MME 5022	Refrigeration and Cryogenic Systems
MME 5020	Design of Heat Exchangers	MME 5023	Steam and Gas Turbines
MME 5021	Measurements in Thermal Engineering	MME 5024	Wind Energy Technology

OPEN ELECTIVES			
MME 5053	Corrosion Science	MME 5057	Industrial Safety Engineering
MME 5054	Creativity for Product Design	MME 5058	Lean Manufacturing
MME 5055	Design of Experiments	MME 5059	Renewable Energy Technology

SEMESTER I

MAT 5155 APPLIED NUMERICAL METHODS [3 1 0 4]

Interpolations, Numerical Differentiation and Integration, Solution of linear and nonlinear system of equations: direct methods and iterative methods, Eigen values & Eigen vectors using Power Method. Numerical Solution of Ordinary Differential Equations, Initial Value Problems: Single step methods. Multi step methods, Boundary Value Problems: Finite difference method. Numerical Solution of Partial Differential Equations, Elliptic P.D.E, Parabolic P.D.E, Hyperbolic P.D.E.

References:

1. Atkinson K. E: An Introduction to Numerical Analysis, Edn 3, John Wiley and Sons, 1989.
2. Carnahan, Luther and Wikes: Applied Numerical Methods, TMH, 1969.
3. Hilderband F. B: Introduction to Numerical Analysis, Edn 5, Tata McGraw Hill, New Delhi, 2013.
4. Conte S. D and Be Door: Elementary Numerical Analysis: An Algorithmic Approach, Edn 3, McGraw Hill, 1981.
5. Gerald C.F. and Patrick D. Wheatley: Applied Numerical Analysis, Edn 7, Addison Wesley, 2004.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References

1. Ranjit Kumar: Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger: Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004.
4. Suresh C. Sinha and Anil K. Dhiman: Research Methodology, Vedam Books, 2006.
5. C. R. Kothari: Research Methodology: Methods and Techniques, New Age International Publisher, 2008.

MME 5191 ADVANCED FLUID DYNAMICS [3 1 0 4]

Basic Conservation Laws: Continuum concept, Eulerian and Lagrangian concept, material derivative, transport theorem, conservation of mass (continuity equation), Derivation of Navier-Stokes equations: Rotation and shear rate, constitutive equations, viscosity coefficient, Navier-Stokes equations, energy equation, boundary conditions, Flow kinematics and Special forms of the governing equations: Streamlines, pathlines, streaklines, circulation, vorticity, stream tubes, vortex tubes, kinematics of vortex lines, Kelvin's theorem, Bernoulli equation, Crocco's equation, Vorticity equation, Two-dimensional potential flows: Stream function, complex potential, source & sink flow around edges, doublet, circular-cylinder flow with/without circulation, Blasius' integral laws, force and momentum on a circular cylinder, conformal transformations, Joukowski transform, flow around ellipses, Exact solutions: Couette flow, Poiseuille flow, flow between rotating cylinders, Stokes' first problem, Stokes' second problem, pulsating flow between plates, stagnation -point flow, convergent-divergent channel flow, porous-wall flow, Boundary layer in the fluid flow: Concept of boundary layer and its importance, mathematical background of boundary layer theory, mechanism of boundary layer formation, Boundary layer analysis: Boundary layer equations for two-dimensional incompressible flow, flat-plate boundary layer, derivation of Blasius equation, numerical solution of Blasius equation, analysis of boundary layer solution, boundary layer thickness, derivation of the Falkner-Skan equations, flow over a wedge shaped body, exact solutions to the steady 2D boundary layer equations, wake flow after a finite flat plate, wake flow after a 2D body, two dimensional planar jet flow

References:

1. G. Currie: Fundamental Mechanics of Fluids, Marcel Dekker, Inc., 2003.
2. F. M. White: Viscous Fluid Flow, Mc Graw Hill. Inc., 2006.
3. T. C. Papanastasiou, G. C. Georgiou and A. N. Alexandrou: Viscous Fluid Flow, CRC Press LLC, 2000.
4. H. Schlichting: Boundary layer theory, Mc Graw Hill. Inc., 1979.

MME 5192 DESIGN OF THERMAL SYSTEMS [3 1 0 4]

Modeling of Thermal Systems: Types of models, Mathematical modeling, Curve fitting, Linear algebraic systems, Numerical model for a system, System simulation, Methods for numerical simulation. Acceptable Design of a Thermal System: Initial design, Design strategies, Design of systems from different application areas, Additional considerations for large practical systems; Economic Considerations: Calculation of interest, Worth of money as a function of time, Series of payments, Raising capital, Taxes, Economic factor in design, Application to thermal systems. Problem Formulation for Optimization: Optimization methods, Optimization of thermal systems, Practical aspects in optimal design, Lagrange multipliers, Optimization of constrained and unconstrained problems, Applicability to thermal systems; Search methods: Single-variable problem, Multivariable constrained optimization, Examples of thermal systems; Geometric, linear, and dynamic programming and other methods for optimization, Knowledge-based design and additional considerations, Professional ethics.

References:

1. W.F. Stoecker: Design of Thermal Systems, McGraw-Hill, 1971.
2. Y. Jaluria: Design and Optimization of Thermal Systems, CRC Press, 2007.
3. Adrian Bejan, George Tsatsaronis and Michael Moran Thermal Design and Optimization, Wiley, 1996.
4. R. F. Boehm: Developments in the Design of Thermal Systems, Cambridge University Press, 1997.
5. N.V. Suryanarayana: Design & Simulation of Thermal Systems, McGraw-Hill, 2002.

MME 5193 FEM FOR THERMAL ENGINEERING [3 1 0 4]

Brief review of Discrete FEM analysis for simple thermal and fluid systems. Shape function generation methods and Gaussian Integration schemes.The general Galerkin weighted residual formulation and application to different classes of heat and fluid flow systems. The variational finite element formulation and its application to heat and fluid flow problems. Basic extension of the above methods to computational fluid dynamics

.

References:

1. Lewis, Nithiarasu, Seetharamu: Fundamentals of the Finite Element Method for Heat and Fluid Flow, John Wiley & Sons Ltd, UK, 2004.
2. David V Hutton: Fundamentals of Finite Element Analysis, Tata McGraw Hill. India, 2007.
3. Daryl L Logan: A First course in Finite Element Method, Edn 4, Thompson Ltd, India, 2007.
4. P. Seshu: Text Book of Finite Element Analysis, Print 5, Prentice Hall of India, New Delhi, 2012.
5. Chandrupatla, T. R. and Belegundu, A. D: Introduction to Finite Elements in Engineering. Pearson Education. New York, 2001.

MME 5194 SOLAR THERMAL ENERGY SYSTEMS [3 1 0 4]

Solar radiation geometry: Radiation on tilted surfaces, Incident angle. Liquid Flat Plate Collectors: Forced and thermosiphon system - Energy balance, H-W-B equation, Transient analysis, ASHRAE test standard and procedure, arrangement of array, Instrumentation, Uncertainty analysis, Load estimation. Evacuated Tube Collectors: Conduction heat transfer phenomena at very low pressure, Thermal analysis, H-W-B constants. Air heaters: Performance analysis of various air heaters, Finned and porous absorbers, Testing procedure and performance curves, Thermal analysis of cabinet drier. Concentrating Collectors: Thermodynamic and optical limit to concentration, Cylindrical parabolic system (PTC), Thermal analysis Heat transfer augmentation techniques, Thermal analysis of solar power plant, Compound parabolic collector, Performance analysis, Paraboloid dish collector, Thermal analysis, Central receiver tower system. Other Systems: Box and dish type cooker, Figure of merit, Desalination, Thermal analysis of single slop system, Fresnel reflector, Solar pond, Solar refrigeration, Adsorption and absorption systems. Energy Storage: Sensible and latent heat storage, Design of storage system, Selection of storage material, Analysis of packed bed system.

References:

1. Duffie J. A and Beckman, W. A: Solar Engineering of Thermal Process, John Wiley, 1991.
2. D. Yogi Goswami: Principles of solar engineering, CRC Press, 2015.
3. Soteris A. Kalogirou: Solar Energy Engineering, Academic Press, 2014.
4. G. N. Tiwari, Solar Energy, Narosa Publications, 2014.
5. S. P. Sukhatme & J.K. Nayak: Solar Energy, Tata McGraw Hill, 2012.

5166 FEA LAB ON THERMAL SYSTEMS [0 0 6 2]

Steady state thermal analysis of one dimensional bar with different boundary conditions, Steady state heat transfer analysis of two dimensional fins of different cross sections [circular, rectangular and tapered], Steady state heat transfer in a composite wall: two dimensional and three dimensional analyses, Two dimensional and three dimensional structural analyses, Unsteady state heat transfer analysis of a heated bar, sphere etc., Thermal stress analyses (2D and 3D), Writing of macros for thermal analysis, Parametric study of thermal components, Design optimization of thermal and structural components, Heat exchanger transient analysis using FLOWNEX, Steady state performance analysis of thermal power plant using FLOWNEX.

Mini-projects related to thermal and structural analysis,

References:

1. Lewis, Nithiarasu, Seetharamu: Fundamentals of the Finite Element Method for Heat and Fluid Flow, John Wiley & Sons Ltd, UK, 2004.
2. ANSYS user manual.
3. FLOWNEX user manual.

MME 5167 THERMAL LAB [0 0 3 1]

Analysis of: (a) Heat Exchangers: Packed bed, Finned tube nanofluid based double pipe and Plate heat exchanger. Cooling tower in forced and natural mode. (b) Energy systems: Air conditioner, Vapor absorption refrigerator, Centrifugal fan, Gas turbine and heat pipe. Computerized C I engine. (c) Other systems: Aerofoil structures using wind tunnel, PCM based thermal energy storage system and transient heat conduction. Calibration of various temperature transducers, Measurement of calorific value of solid/liquid fuel using bomb calorimeter and Dryness fraction of steam using separating and throttling calorimeter.

References:

1. Holman J. P: Experimental methods for Engineers, Mc Graw Hill. Inc, 1994.
2. E. O. Doeblin: Measurement systems: Applications and Design, Tata Mc Graw Hill, 2004.
3. Alan S. Morris: Principles of measurement and instrumentation, Prentice Hall of India, 2002.
4. Sadik Kakac: Heat exchangers: Selection, rating, and thermal design, CRC Press, 2012.

SEMESTER II

MME 5291 COMPUTATIONAL FLUID DYNAMICS [3 1 0 4]

Models of Flow and derivation of governing conservation differential equations for different models for conservation of mass, momentum and Energy. Discussion of characteristics and Boundary and Initial conditions. Basic numerical methods to solve first diffusion related flow physics followed by Convective dominated Diffusion flows. Difficulties and strategies to solve such flows. Algorithmic approach and convergence as well as stability. Turbulence and related closure using turbulence modelling.

References:

1. John D Anderson Jr: Computational Fluid Dynamics- The Basics with Applications, International Edition. McGraw Hill. New York, 1995.
2. Suhas V Patankar: Numerical Heat Transfer and Fluid Flow, Hemisphere / McGraw Hill. New York, 1980.
3. H. K. Versteeg and W. Malalasekera: An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Longman Scientific & Technical. England, 1995.
4. K. Muralidhar and T. Sundararajan: Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.
5. Tennekes H. and Lumley J. L: A First Course in Turbulence, The MIT press, 1972.

MME 5292 ENERGY MANAGEMENT, CONSERVATION AND STORAGE [3 1 0 4]

Energy Management & Audit **:** Present Energy Scenario, Energy Management Principles, energy audit, insulation, Power factor improvement methods, Electrical lighting and energy conservation methods, Waste heat recovery devices, Cogeneration principles, methods, types and Performance evaluation of cogeneration system, Performance evaluation of Boilers, furnaces diesel Generators, Pumps, Cooling towers. Energy storage: Pumped hydro storage, Compressed gas system: Electrical and magnetic energy storage: Capacitors, electromagnets, Chemical Energy storage,: Solar Ponds for energy storage, stratified storage systems; Rock-bed storage systems, Thermal storage in buildings, Phase Change Materials (PCMs), Selection criteria of PCMs, Energy conservation through LHTES systems, LHTES systems in refrigeration and air-conditioning systems.

References:

1. Paul W. O'Callaghan: Energy Management – A comprehensive guide to reducing costs by efficient energy use, McGraw Hill, England, 1992.
2. W.C Turner: Energy management Handbook, Edn. 7, Fairmont Press, 2007.
3. BEE (Bureau of energy efficiency) Study Material, Energy Management & Energy Audit, (www.bee-india.com)
4. Johannes Jensen Bent Squrensen: Fundamentals of Energy Storage, John Wiley, NY, 1984.
5. Ibrahim Dincer: Thermal Energy Storage: Systems and Applications, Wiley Publications, 2010.

MME 5269 CFD LAB [0 0 3 1]

Introduction to ANSYS Workbench software, Laminar flow and Turbulent Flow in a rectangular duct, Turbulent flow in a cylindrical pipe-Axisymmetric analysis, Turbulent flow in a pipe bend, Simulation of steady state heat transfer for air/water flow through a finned pipe, Transient heat transfer in a bar subjected to annealing process, Periodic flow simulation of a bank of tubes of a heat exchanger, Wind tunnel simulation of flow over a blunt body, Flow over an aero-foil at different angle of incidence, 3D Steady state conductive and convective heat transfer analysis, Simulation of flow and heat transfer through a solar air heater, Simulation of flow through a turbo machine, Simulation of two phase flow through a Convergent-Divergent nozzle.

References:

1. John D Anderson Jr: Computational Fluid Dynamics- The Basics with Applications. International Edition. McGraw Hill. New York, 1995.
2. ANSYS workbench User manual.

MME 5265 RENEWABLE ENERGY LAB [0 0 3 1]

Performance of Solar systems: (a) Water heaters: Flat plate collector in forced and thermosiphon mode with simulated solar radiation / outdoor condition. Evacuated tube collector. (b) Concentrators: Dual axes parabolic trough and Paraboloid type. (c) Cookers: Box and paraboloid type. (d) Others: Flat plate air heater and single slope still. (e) PV systems: Training and research system, grid tied training system and PV emulator. Wind energy: Training system and emulator. Energy Audit: (a) D.G. set and Boiler installed in the campus. (b) Performance assessment of Centrifugal pump.

References:

1. G. N. Tiwari: *Solar Energy*, Narosa Publications, 2014.
2. S. P. Sukhatme and J. K. Nayak: *Solar Energy*, Tata McGraw Hill, 2012.

SEMESTER III & IV

MME 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

MME 5019 ADVANCED HEAT TRANSFER [3 1 0 4]

Steady state heat conduction: Energy balance for solid, concept of generation and storage, types of boundary conditions. steady state heat conduction through plane, cylindrical and spherical walls, formulation of steady combined conduction, convection problems and their analytical solutions – heat transfer characteristics of straight, annular, and pin-fins of uniform and non-uniform cross sections. formulation of steady two-dimensional heat conduction problems in rectangular, and cylindrical geometries and their analytical solutions, method of separation of variables, homogeneous and nonhomogeneous problems, partial solutions, variation of parameters, principle of superposition, Transient heat conduction: Formulation and solution of unsteady heat conduction problems, initial conditions, multidimensional transients, lumped system analysis, Convection heat transfer: Conservation principles, derivation of continuity, momentum and energy equations, Concept of viscous and thermal boundary layer, Prandtl number, differential equations for the laminar and turbulent boundary layers, laminar internal flow and heat transfer; concept of fully developed velocity and temperature profile, solutions for constant heat flux and constant wall temperature boundary conditions. solution of entry length problem for constant heat flux and constant wall temperature boundary conditions, Laminar external boundary layers; momentum transfer, heat transfer, turbulent boundary layer and heat transfer, convective heat transfer with body forces

References:

1. Myers G. E., Analytical Methods in Conduction Heat Transfer, McGraw-Hill, 1998.
2. Kays W., Crawford M., Weigand B., Convective Heat and Mass Transfer, McGraw-Hill, 2005.
3. Bejan A, Convection Heat Transfer, Wiley, 2013.
4. Cengel Y. A., Heat and Mass Transfer, McGraw-Hill, 2007.

MME 5020 DESIGN OF HEAT EXCHANGERS [3 1 0 4]

Heat exchangers: Design methods and calculation, convection correlations, pressure drop and pumping power calculations, fouling of heat exchangers. Micro and nano heat transfer: Flow in micro channels, Convective heat transfer with nano-fluids and analysis. Double pipe heat exchangers: Thermal and hydraulic analysis, bare and finned tube analysis, parallel – series arrangements. Shell and tube heat exchangers: Types, basic components, layout and geometry, stream allocation, design procedure, Kern and Bell-Delaware method. Design of condensers and evaporators: Condensation in horizontal and vertical tubes, Thermal design of shell and tube condensers, horizontal and vertical condensers with tube side and shell side condensation, flow boiling correlations, Thermal design of evaporators. Compact heat exchangers: Heat transfer and pressure drop calculations. Plate heat exchangers, Thermal performance. Fired process heaters and furnaces: Types, fundamentals of combustion, heat transfer and heat balance in fired heaters, furnace heat transfer, Cooling towers: Classification, concept of psychrometry, energy balance, design and analysis. Testing of Heat Exchangers: Performance evaluation and testing procedures.

References:

1. Sadik Kakac: Heat exchangers: Selection, rating, and thermal design, CRC Press, 2012.
2. Robert W Serth: Process Heat Transfer: Principles, Applications and Rules of Thumb, Academic Press, 2014.
3. Donald Q Kern: Process heat transfer, McGraw Hill Publication, 1997.
4. Kays W. M. and London A.L: Compact Heat Exchangers, McGraw-Hill, 1998.
5. Ramesh K Shah: Fundamentals of heat exchanger design, John Wiley and sons, 2003.

MME 5021 MEASUREMENTS IN THERMAL ENGINEERING [3 1 0 4]

Planning of Experimental Investigation: Theoretical and experimental approaches, Uncertainty analysis, Use of softwares in regression analysis. Temperature and Heat flux measurement: Thermal expansion methods Electrical methods, Thermocouple classification and coding, Cold junction compensation, Data acquisition and processing, Measurement in high speed flow, Radiation methods, Calibration of temperature measuring devices, Heat flux and heat transfer coefficient measurement. Pressure Measurement: Balancing liquid column, Elastic deformation, Electrical methods, Pressure switches, Calibration, Digital transducers, Selection criteria. Flow Measurement: Variable head meters, Compressible flow measurement, Uncertainty analysis, Variable area meters, Measurement and calibration of flow measuring devices for compressible and incompressible fluids, other types of flow measuring devices, Selection criteria. Measurement of Velocity: Pitot tube, Compressible and Incompressible flow, Hot wire anemometer, Time of flight velocimeter, Ultrasonic doppler.

References:

1. Holman J. P: Experimental methods for Engineers, Mc Graw Hill. Inc, 1994.
2. E. O. Doeblin: Measurement systems: Applications and Design, Tata Mc Graw Hill, 2004.
3. Alan S. Morris: Principles of measurement and instrumentation, Prentice Hall of India, 2002.
4. S. P. Venkateshan: Mechanical measurements, Ane Books India, 2008.
5. Beckwith: Mechanical Measurements, Peasrson Education, India, 2005

MME 5022 REFRIGERATION AND CRYOGENIC SYSTEMS [3 1 0 4]

Principles of Refrigeration**:** Vapour compression cycle, Actual vapour compression cycle, Multistage systems, Cascade system, Gas cycle refrigeration for Aircraft applications: thermal load Estimation, Selection and matching of components, capacity control, requirements of refrigerants and Lubricants, Secondary and Mixed refrigerants. Theory of Mixtures: Enthalpy composition diagrams, principle of Absorption system, Aqua ammonia systems, LiBr water system, three fluid absorption systems, solar refrigeration system. Cryogenic Systems**:** Introduction, Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction; Cycles. Inversion Curve, Joule Thomson Effect, Liquefaction Cycles: Linde Hampson Cycle, Pre-cooled Linde-Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Refrigerated Hydrogen Liquefaction Systems. Critical components in Liquefaction Systems. Cryogenic Refrigerators: J.T.Cryo-coolers, Sterling Cycle Refrigerators, G.M.Cryo-coolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators Applications: Applications of Cryogenics in Space programs, Superconductivity, Cryo Metallurgy, Medical applications.

References:

1. Manohar Prasad: Refrigeration and Air Conditioning, New age international Publishers, 2015.
2. W.F Stocker and J.W. Jones: Refrigeration and Air-conditioning Data, McGraw Hill, 1985.
3. K. D. Timmerhaus and T.M. Flynn: Cryogenic Process Engineering, Plenum Press, 1989.
4. R. F. Barron: Cryogenic Systems, McGraw Hill, 1985.

MME 5023 STEAM AND GAS TURBINES [3 1 0 4]

Nozzles and diffusers: Equation of continuity and momentum, Parameters affecting the performance of nozzles. Impulse steam turbines: Compounding of Impulse turbine, Impulse–Reaction turbine, Combination turbines, Stage efficiency, Efficiency of multistage impulse turbine. Flow of Steam through Impulse-Reaction Turbine Blades: Velocity diagram, Degree of reaction, State Point Locus Reheat Factor and design, Reheat factor for different work condition, Correction of reheat factor for finite number of stages, Design procedure of impulse and impulse- reaction turbines. Axial Flow and Centrifugal Compressors: Compressibility effects, Degree of reaction, Design process and blade design. Shaft power cycles and gas turbine cycles for air-craft propulsion, Turbo fan engine, Turbo prop engine, Thrust augmentation. Axial and Radial Flow Gas Turbines and Prediction of Performance: Vortex theory, Estimation of blade performance, Off-design operation, Methods of displacing the equilibrium running line, Incorporation of variable pressure losses. Jet and Rocket Propulsion: Different jet engines, Thrust equation, Principles of rocket propulsion, Ideal chemical rocket, Free radical propulsion, Nuclear propulsion, Electro dynamics propulsion, Photon propulsion.

References:

1. R. Yadav: Steam and Gas Turbines, Central Publishing House, Allahabad, 2009.
2. H.I.H. Saravanamuttoo, G.F.C. Rogers & H Cohen: Gas Turbine Theory, Edn 6, Pearson Education, 2008.
3. V. Ganesan: Gas Turbines, Edn 3, Tata McGraw-Hill Publications, 2010.

MME 5024 WIND ENERGY TECHNOLOGY [3 1 0 4]

Wind Energy Conversion: Power, torque and speed characteristics, Wind data analysis. Wind Characteristics: Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution. Wind measurements: Wind speed and direction measurement, Rotational and other anemometers. WECS Design: Aerodynamic theories, Rotor characteristics, Maximum power coefficient; Prandlt's tip loss correction. Design of Wind Turbine: Theoretical simulation of wind turbine characteristics, Test methods, Power output from practical turbines, Transmission and generation efficiency. Wind turbine connected to electrical network: Methods of generating synchronous power, Synchronous generator, Induction machine, Asynchronous Electric Generators. Wind Energy Application: Performance analysis, design concept and testing of piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries. Economics of wind energy utilization: Capital costs, Economic revenues requirements, value of wind generated electricity, Wind energy in India, Case studies.

References:

1. Johnson G L: Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.
2. Spera David A: Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers, 1994.
3. Desire L Gouriers: Wind Power Plants: Theory and Design, Pergamon Press, 1982.
4. Paul Gipe , Karen Perez: Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company, 1999.
5. Hau Erich: Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Verlag, 2000.

OPEN ELECTIVES

MME 5053 CORROSION SCIENCE [3 0 0 3]

Importance of corrosion study: Factors affecting corrosion, Economical aspects of corrosion. Fundamental aspects of corrosion: Formation of a corrosion Cell, Cathodic and anodic corrosion reactions and characteristics, Hydrogen and Calomel electrode, Pourbaix diagram for metal-water system. Principles of corrosion: Nernst's Equation, Electrochemical corrosion in aqueous medium, Faradays' laws of electrolysis, Corrosion potential, Corrosion current density, Factors affecting corrosion rate. Types of corrosion: Characteristic features, causes and control measures for different types of corrosion, Introduction to high temperature corrosion, Corrosion/Chemical degradation of non-metallic materials. Polarization: Thermodynamics and Kinetics of Electrode Processes, Gibb's free energy of adsorption, Equilibrium constant, Activation energy, Physical & chemical adsorption. Corrosion control: Material selection, Design considerations, Control of environment including Inhibitors and Passivators, Cathodic and anodic protection, Coatings, Electroplating and other techniques, Case studies on Corroison control. Corrosion Monitoring: Accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by Gravimetric, Tafel polarization, Linear polarization, Cyclic polarization, Impedance spectroscopy, NDT techniques - Ultrasonic, Radiography and Eddy current method, Case studies on corrosion monitoring.

References:

1. Mars G. Fontana: Corrosion Engineering, Edn 3, Tata McGraw Hill, New Delhi, 2008.
2. Zaki Ahmed: Principles of Corrosion Engineering and Corrosion Control, Elsevier Science and Technology Books, 2006.
3. Trethewey K. R. and Chamberlain Longman J: Corrosion for students of science and engineering, Scientific & Technical New York, USA, 1988.
4. Philip A Schweitzer: Fundamentals of corrosion-Mechanisms, Causes and preventive methods, CRC Press, Taylor and Francis Group, Boca Raton, 2010.
5. Uhlig H.H. and Revie R. W: Corrosion and Corrosion Control, Wiley, NY, 1985.

MME 5054 CREATIVITY FOR PRODUCT DESIGN [3 0 0 3]

Product Design: Process, 3 S's, strength considerations in product design. Tools for design: Different tools, Taguchi technique for robust design, Design for Manufacture, Rapid prototyping, Role of concurrent engineering, reverse engineering. Creative thinking: The five dimensions of creativity. Basic Probability concepts: Central Limit Theorem and sampling distributions, probability density function. Reliability of Components and Systems: Reliability, Factor of safety and reliability theory, Reliability management, history of reliability engineering; failure modes, failure data analysis, failure rate, time curve, reliability and hazard functions, hazard models, estimation of failure rate, mean time before failure, system reliability, complex systems, reliability enhancement, maintainability and availability, repairable systems, reliability allocation, event-tree and fault-tree analyses, reliability testing.

References:

1. Ulrich Karl T. and Eppinger Steven D: Product Design and Development, McGraw Hill International Edition, 1999.
2. Rosenthal Stephen: Effective Product Design and Development, Business One Orwin Homewood, 1992.
3. Dieter: Engineering Design, McGraw Hill International Edition, 1990.
4. Day Ronald G: Quality Function Deployment, Tata McGraw Hill, 1990.
5. Goldenberg and Mazursky: Creativity in Product Innovation, Cambridge University Press, 1996.

MME 5055 DESIGN OF EXPERIMENTS [3 0 0 3]

Understanding basic design principles, Working in simple comparative experimental contexts, introduction to R language and its applications in DOE problems, Working with single factors or one-way ANOVA in completely randomized experimental design contexts, Implementing randomized blocks, Latin square designs and extensions of these, Understanding factorial design contexts, Working with two level, 2*k*, designs, Implementing confounding and blocking in 2*k* designs, Working with 2-level fractional factorial designs, Working with 3-level and mixed-level factorials and fractional factorial designs, Simple linear regression models, Understanding and implementing response surface methodologies, Understanding robust parameter designs, Working with random and mixed effects models, Design of computer experiments and the applications in industrial engineering problems.

References

1. Montgomery, D. C: Design and Analysis of Experiments, John Wiley & Sons. Inc., 2001.
2. Dean, A. M. and Voss, D. T: Design and Analysis of Experiments (Springer text in Statistics), Springer Science + Business Media, 1999.
3. Box, G. E. P., Hunter, W. G., and Hunter, J. S: Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building, John Wiley & Sons, 1978.
4. Diamond, W. J: Practical Experiment Designs for Engineers and Scientists, John Wiley & Sons, 2001.
5. Jeff Wu, C. E. and Hamada, M. I: Experiments: Planning, Analysis, and Parameter Design Optimization, John Wiley & Sons, 2000.

MME 5057 INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]

Basics: Accidents & their effects; Cost of accidents; Theories of accident causation, Management failures in accident causation, Accident investigation and reporting. Industrial Hazards: Various Hazards, Blood borne pathogens in the workplace. National Safety Council of India (NSCI) and Industrial Safety Acts: Mission and Vision, Hazard and operational (HAZOP) studies, Document preparation, Various acts. Industrial Safety Analysis and Management: Hazard analysis, Human error analysis (HEA), Technic of operation review (TOR), Fault tree analysis, Applying and evaluating safety and health instruction; Training supervisors; Training new and transferred employees. Environmental Safety: Safety, health and environment; Legislation and Regulation; Types of environment, Hazards of the environment; OSHA hazardous waste standard; Environmental management system (EMS); ISO 14000 series of standards; Ethics and safety.

References:

1. David L. Goetsch: Occupational Safety and Health for Technologists, Engineers and Managers, Edn 5, Pearson-Prentice Hall, 2005.
2. Frank R. Spellman and Nancy E. Whiting: The Handbook of Safety Engineering: Principles and Applications, The Scarecrow Press Inc., 2010
3. Amit Kumar Gupta: Industrial Safety and Environment, Laxmi Publications (P) Ltd., 2006
4. National Safety Council India, "NSC," [Online]. Available: http://nsc.org.in/.
5. Ministry of Labour and Employment, "Ministry of Labour and Employment," [Online]. Available: http://nsc.org.in/.

MME 5058 LEAN MANUFACTURING [3 0 0 3]

Introduction: 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, Total Productive Maintenance, 5S system, Standardization of Work, Elements of standardized work, Charts to define standardized work, man power reduction, Overall Equipment Efficiency, Standardized work and KAIZEN, Case study. Standardization of operations: Multi-function workers and job rotation, Improvement activities to reduce work force and increase worker morale foundation for improvements. Just In Time Principles of JIT, JIT system, Kanban and its rules, Expanded role of conveyance, production leveling, Pull systems, Value stream mapping, Case study. Shortening of production lead times: Reduction of setup times, practical procedures for reducing setup time. Jidoka concept – Poka-yoke systems, Inspection systems and zone control, types and use of poka-yoke systems, Implementation of jidoka, Case studies.

References:

1. Chasel Aquilino: Productions and Operations Management, Dreamtech, 2005.
2. Yasuhiro Monden: Toyoto Production System -An integrated approach to Just in Time, Institute of Industrial Engineers Norcross Georgia, 1983.
3. James P Womack, Daniel T Jones and Daniel Roos: The Machine that changed the World. The Story of Lean Production - -Harper Perennial - edition published, 1991.
4. James Womack and Daniel T Jones: Lean Thinking, Edn 2, 2003.
5. Richard Schourberger, Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - ASQC Press, 1991.

MME 5059 RENEWABLE ENERGY TECHNOLOGY [3 0 0 3]

Solar energy: Sun-Earth angles, Measuring techniques and estimation of solar radiation, Applications of Solar energy. Energy from biomass: Sources of biomass, Conversion of biomass into fuels, Properties of biomass, Types of biogas plants, Design and operation. Wind energy: Principles of wind energy conversion, Site selection considerations, Wind power plant design, Types of wind power conversion systems, Operation, maintenance and economics. Fuel Cell: Components of fuel cells, Principle, Performance characteristics of fuel cells, Efficiency, Fuel cell power plant. Geothermal and Ocean energy: Geothermal fields, Energy conversion technologies, Ocean energy, Scope and economics, Introduction to integrated energy systems.

References:

1. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994.
2. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977.
3. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978.
4. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002.
5. H.P. Garg, S.C. Mullick and A.K. Bhargava: Solar Thermal Energy Storage, 1985.

DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING, MIT Manipal

M.Tech. MANUFACTURING ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 5155	Applied Numerical Methods	3	1	0	4	MME 5275	Design of Manufacturing Tools	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	MME 5276	Production Automation	3	1	0	4
	MME 5175	Advanced Manufacturing Technology	3	1	0	4	MME ****	Elective I	3	1	0	4
	MME 5172	Advanced Materials and Characterization	3	1	0	4	MME ****	Elective II	3	1	0	4
	MME 5173	Fluid Power Automation	3	1	0	4	MME ****	Elective III	3	1	0	4
	MME 5174	Theory of Metal Cutting	3	1	0	4	*** ****	Open Elective	3	0	0	3
	MME 5169	Advanced Material Testing Lab	0	0	3	1	MME 5284	Finite Element Analysis Lab	0	0	3	1
	MME 5170	Geometric Modelling Lab	0	0	6	2	MME 5263	Industrial Automation Lab	0	0	3	1
		Total	**16**	**5**	**12**	**25**		**Total**	**18**	**5**	**6**	**25**
	THIRD AND FOURTH SEMESTER											
II	MME 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
MME 5004	Computational Fluid Dynamics	MME 5012	Advanced Heat Treatment
MME 5005	Finite Element Methods	MME 5013	Design for Manufacturing
MME 5010	Additive Manufacturing	MME 5014	Fracture Mechanics
MME 5011	Advanced Metal Casting and Joining	MME 5015	Mechanics of Composite Materials

OPEN ELECTIVES			
MME 5053	Corrosion Science	MME 5057	Industrial Safety Engineering
MME 5054	Creativity for Product Design	MME 5058	Lean Manufacturing
MME 5055	Design of Experiments	MME 5059	Renewable Energy Technology

SEMESTER I

MAT 5155 APPLIED NUMERICAL METHODS [3 1 0 4]

Finite differences, Netwon-Gregory and Lagrange's interpolation formulae, Inverse interpolation, Newton divided difference interpolation formula. Numerical differentiation and integration-Newton's Cote's quadrature formula, Errors in quadrature formulae. Solution of linear and nonlinear system of equations: Direct methods, Indirect Methods (Iterative methods). Numerical solution of ordinary differential equations. Multi step methods: Adam Bashforth's predictor corrector method, Milne's predictor and corrector method. Boundary value problems: Finite difference method, Numerical solution of partial differential equations, Elliptic partial differential equations : Laplace equation, Poisson equation, explicit finite difference method, Derivative boundary condition, Iterative method, ADI method, Parabolic partial differential equations: Non dimensional form of heat equation, Explicit finite difference scheme, Hyperbolic partial differential equations: Method of Characteristics, Solution of hyperbolic equation by characteristics, Finite difference methods and explicit finite difference method, implicit method, Finite element methods.

References:

1. Atkinson K.E, An Introduction to Numerical Analysis, (3e), John Wiley and Sons, 1989.
2. Carnahan, Luther and Wikes, Applied Numerical Methods, New Edition, TMH, 1969.
3. Hilderband F.B, Introduction to Numerical Analysis, (5e), Tata McGraw Hill, New Delhi.
4. Conte S.D and Be Door, Introduction to Numerical analysis, McGraw Hill.
5. Gerald C.F. and Patrick D. Wheatley, Applied Numerical Analysis, (3e), Addison Wesley, 1984.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Ranjit Kumar, Research Methodology- A Step-By-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of research Design and Methodology, John Wiley and Sons, 2004.
3. John W Creswel, Research Design- Qualitative, Quantitative and Mixed Methods Approaches, SAGE, 2004.
4. Suresh C. Sinha and Anil K Dhiman, Research Methodology (2 volume-set), Vedam Books, 2006.
5. Kothari C. R., Research Methodology- Methods and Techniques, New age International Publisher, 2008.

MME 5175 ADVANCED MANUFACTURING TECHNOLOGY [3 1 0 4]

AJM, WJM, AWJM and USM working principles, Equipment, Process parameters, Electrical EDM & WEDM - working principles, Equipment, Process parameters, CHM and ECM working principles, Equipment, Process parameters, LBM, PAM, EBM- working principles, Equipment, Process parameters, Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting, Electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW), Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming, and contour roll forming, Rapid manufacturing.

References:

1. Bhattacharya, New technology, Institution of Engineers, India.
2. HMT, Production technology, Tata McGraw Hill.
3. PS Pandy & H.S Shan, Modern Machining Process, Tata McGraw Hill.
4. ASM, Metals hand book, Vol-3.
5. F.M Wilson, High velocity forming of metals, ASTMW Pretice Hall.

MME 5172 ADVANCED MATERIALS AND CHARACTERIZATION [3 1 0 4]

Mechanical Behavior of Materials: Plastic deformation, strengthening mechanisms, damping properties of materials, Propagation of fatigue cracks, Creep mechanisms - Environmental degradation of materials, Selection of materials. Engineering Alloys: Ferrous and non-ferrous alloys used in engineering applications. Modern Materials and Alloys: Super alloys - Refractory metals - Shape memory alloys - Dual phase steels, Micro alloyed, High strength low alloy steel, Transformation induced plasticity (TRIP) steel, SMART materials. Polymeric Materials: Polymeric materials, polymeric structure, properties and applications. Advanced structural ceramics. Surface Modifications of Materials: Mechanical surface treatment and coating – coatings for improving the mechanical properties of material surfaces. Nonmetallic Materials: Composite materials, ceramics and plastics, types and applications. Characterization of Materials: Optical microscopy, X-Ray diffraction, Scanning electron microscopy, Transmission electron microscopy principles, Selected area diffraction, chemical analysis and thermal analysis methods. Characterization of Surfaces: Characterization of surface microstructure & properties, Measurement of coating thickness, Measurement of residual stress & stability, Spectroscopic analysis of modified surfaces.

References:

1. Callister W.D. (2013), Material Science and Engineering- An introduction, Wiley – Eastern, 9th Edition.
2. Thomas H. Courtney, (2000), Mechanical Behavior of Materials, McGraw Hill.
3. Davis, J.R., (2001), Surface Engineering for corrosion and wear resistance, ASM International.
4. Raghavan, V. (2003), Physical Metallurgy, Prentice Hall of India.

MME 5173 FLUID POWER AUTOMATION [3 1 0 4]

Introduction to pneumatic systems, Advantages and limitations, Components of pneumatic system: Air generation and distribution, Constructional details and working of filter, lubricator, pressure regulator, cylinders, Manual pneumatics, Symbols of pneumatic valves, Design of manually operated circuits, control of multiple actuators, Electro pneumatics, Electrically actuated direction control valves, Relay control systems, Limit switches, magnetic, inductive, capacitive, optical, ultrasonic, pneumatic proximity sensors Design of electro pneumatic circuits, Introduction to Hydraulic systems, Hydraulic actuators and accessories, Linear actuators, calculation of force, speed, rotary actuators, accumulator, Hydraulic valves, Construction and working of various types of Direction control valves, Hydraulic circuits.

References:

1. Werner Deppert and Kurt Stoll, Pneumatic Control, VOGEL Buchverlag Wurzburg, Germany, 1992.
2. Majumdar S.R., Pneumatic Systems Principles and Maintenance, Tata McGraw Hill, New Delhi, 2000.
3. Peter Croser, Frank Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, 2002.
4. Prede G. and Scholz D., Electro pneumatics Basic Level, Festo Didactic GMBH & Co, Germany, 2002.
5. Hasebrink J.P. and Kobler R., Fundamentals of Pneumatic Control Engineering" Festo Didactic GMBH & Co, Germany, 2002.

MME 5174 THEORY OF METAL CUTTING [3 1 0 4]

Cutting tool nomenclature, Nomenclature of single point tool, multi-point tool, Effect of cutting parameters on tool geometry, Indexable inserts, ISO specification of tool holders and inserts. Cutting Tool Materials, Desirable properties of tool materials, Mechanics of metal cutting, Mechanisms of chip formation – ductile and brittle materials, Ploughing force, Forces in Machining: Forces in turning, drilling and milling, Measurement of cutting forces – Cutting tool dynamometer, Thermal aspects in metal cutting, Heat sources in metal cutting, Temperature in chip formation, temperature distribution, Properties of cutting fluids, Cutting tool wear and tool life, Different wear mechanisms, reasons for failure of cutting tools, Theory of chatter, Effects of vibration, sources of vibration, Analysis of single and two degrees of freedom chatter.

References:

1. Amitabh Bhattarcharya, Metal Cutting-Theory and Practice, New central Book Agency Pvt. Ltd., Kolkata, 1984.
2. M.C. Shaw, Metal cutting principles, Oxford Publication, 1980.
3. Boothroyd, Fundamentals of Metal Machining, McGraw-Hill Book Company, 1985.
4. B.L. Juneja ,G. S. Sekhon, Fundamentals of Metal cutting & Machine Tools, New Age International (p) Ltd, Second Edition, 2003.
5. V.C. Venkatesh, S. Chandrasekharan, Metal cutting, Prentice Hall, 1985.

MME 5169 ADVANCED MATERIAL TESTING LAB [0 0 3 1]

Heat treatment of steel- Annealing and normalizing, Heat treatment of steel- Hardening and Tempering, Specimen preparation for Image Analyzer, Microstructure analysis of above specimens, Tensile test specimen preparation from the above heat treated specimens, Hardness test for above specimens (Brinel and Rockwell), Wear test, Non-destructive testing, Demonstration on two-high hand operated rolling mill, Analysis using SEM and XRD, use of Autoclave for manufacturing composite material.

References:

1. Serope Kalpakjian, Manufacturing Engineering and Technology, Pearson Education Asia, 2000.
2. Donald R. Askeland, Essentials of material science, Thomson India edition, 2007.
3. Sidney H Avner, Introduction to physical metallurgy, Tata Mc graw hill edition, 1997

MME 5170 GEOMETRIC MODELLING LAB [0 0 6 2]

Sketcher work bench; Part design work bench; Assembly and drawing; Surface Modeling; Mould and sheet metal designs; Creating the model using CMM data.

Mini Project work (Geometric Modelling of complex mechanical components and assemblies)

References:

1. Sham Tickoo, CATIA – for Engineers and Designers, Dreamtech Press, New Delhi, 2005.
2. Kirstie Plantenberg, Introduction to CATIA V5 Release 19, SDC Publications, 2009.

SEMESTER II

MME 5275 DESIGN OF MANUFACTURING TOOLS [3 1 0 4]

Design considerations for cutting tools, design of turning tools, chip breakers, parting-off tool, Form tools design. Design of drilling, reaming, tapping and broaching tools, Design of milling cutters, Introduction on presses and press tools, shearing theory, cutting force clearances between punch and die, methods of reducing cutting force, Tonnage calculation and press tool accessories. Die block calculations, strip layout, simple die, compound die and progressive die, Theory of Bending, bend radii, bend allowances, bending methods. Spring back effect, bending dies, Design of deep drawing dies.

References:

1. Donaldson Cyril, Tool Design, Harper, 2002.
2. Arshenov V., Alekseev G, Metal cutting theory and cutting tool design, MIR Publishers, 1970.
3. Wilson Frank R, Fundamentals of tool design, 1964.
4. Ranganath B J, Metal cutting and tool design, Vikas Publishing House Pvt.Ltd., 2004.
5. CMTI Machine, Tool design handbook, Tata McGraw Hill, 2004.

MME 5276 PRODUCTION AUTOMATION [3 1 0 4]

Fundamentals of Manufacturing and Automation Manufacturing support systems, Automation in production systems, Automation principles & strategies, automated systems & Automation functions, Levels of automation, Components of CNC machines, classification, construction details of CNC machines, machine structure, guideways, spindle, measuring systems, Drives and Controls, CNC Toolings, Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, Modular fixturing, quick change tooling system, Introduction to Robotics Introduction, Robot configuration, Robot motions, Programming the robots, Robot programming languages, End effectors, Work cell, Control and interlock, Robot transformation and sensors, Programmable Logic Controls (PLC) and programming.

References:

1. Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency (P) Ltd.,Kolkata, 2004.
2. GrooverMikell P., Automation, Production Systems, and Computer Integrated Manufacturing, Prenice Hall of India, New Delhi, 2001.
3. HMT Limited, Mechatronics, Tata McGraw Hill publishing company Ltd. New Delhi, 1998.
4. P.N Rao, CAD/CAM Principles and Applications, Tata McGraw Hill Compay, New Delhi, 2009.
5. Thomas Crandell M., CNC Machining and Programming, an Introduction, Industrial Press Inc., New York, 2002.

MME 5284 FINITE ELEMENT ANALYSIS LAB [0 0 3 1]

FEA using ANSYS classic/ workbench, truss analysis, beam analysis, 2D and 3D structural analysis, thermal analysis, Thermo-mechanical analysis of single point cutting tool; Thermo-mechanical analysis of reamer; 2D Finite element simulation of orthogonal cutting.

References:

1. Daryl L Logan, A first course in Finite Element Method, (4e), Thompson Ltd. India, 2007.
2. Segerlind Larry J., Applied finite element analysis, John Wiley, 1984.
3. David W. Nicholson, Finite Element Analysis – Thermo mechanics of Solids, CRC Press Ltd, Washington DC, 2003.

MME 5263 INDUSTRIAL AUTOMATION LAB [0 0 3 1]

Pneumatic controls: pneumatic and electro-pneumatic components and its application circuit, Hydraulic controls: Hydraulic and electro-hydraulic components and its application circuit, CNC Programming: Manual and CAM software based programming for CNC turning and Machining centre, Computer Aided Inspection (CAI), Practice of measuring/inspection using CMM, Robot.

References:

1. Peter Croser, Frank Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, 2002.
2. Prede G. and Scholz D., Electro pneumatics Basic Level, Festo Didactic GMBH & Co, Germany, 2002.
3. Hasebrink J.P. and Kobler R., Fundamentals of Pneumatic Control Engineering, Festo Didactic GMBH & Co, Germany, 2002.

PROGRAM ELECTIVES

MME 5004 COMPUTATIONAL FLUID DYNAMICS [3 1 0 4]

Models of Flow and derivation of governing conservation differential equations for different models for conservation of mass, momentum and energy. Discussion of characteristics and boundary and initial conditions. Basic numerical methods to solve first diffusion related flow physics followed by convective dominated diffusion flows. Difficulties and strategies to solve such flows. Algorithmic approach and convergence as well as stability. Turbulence and related closure using turbulence modelling.

References:

1. John D Anderson Jr, Computational Fluid Dynamics- The Basics with Applications. International Edition. McGraw Hill. New York, 1995.
2. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow. Hemisphere / McGraw Hill. New York, 1980.
3. H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics- The Finite Volume Method. Longman Scientific & Technical. England, 1995.
4. K.Muralidhar and T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.
5. Tennekes H. and Lumley J.L., A First Course in Turbulence, The MIT press, 1972.

MME 5005 FINITE ELEMENT METHODS [3 1 0 4]

Introduction: General procedure of FEM. Formulation Methods - Direct Method: Spring and truss elements, arbitrarily oriented elements, transformation matrix, plane truss. Energy Method: Principle of total minimum potential energy, Formulation of plane stress/strain elements. Galerkin's Weighted Residual Method: Beam theory, formulation of beam element, arbitrarily oriented beam elements, plane frame. Isoparametric Elements: Formulation of truss, plane and solid elements. Introduction to Analysis Types: Modal or frequency analysis, thermal analysis, thermos-structural analysis, axi-symmetric analysis, fluid flow analysis.

References:

1. Daryl L Logan, A First Course in Finite Element Method, Thomson Asia Pvt. Ltd, Bangalore, 2002.
2. Bathe K J, Finite Element Procedures, Prentice Hall of India New Delhi, 2003.
3. Martin H.C. and Carey G.F., Introduction to Finite Element Analysis, Tata McGraw Hill, New Delhi, 1975.
4. Segerlind L J., Applied Finite Element Analysis, John Wiley, New York, 1984.
5. Cook Robert D, Concepts and Applications of Finite Element Analysis, John Wiley and Sons New York, 2000.

MME 5010 ADDITIVE MANUFACTURING [3 1 0 4]

Introduction to Additive Manufacturing: General overview, Traditional manufacturing vis AM Computer aided design (CAD) and manufacturing (CAM) and AM. Different AM processes and relevant process physics. AM process chain. Application level of AM: Direct processes and Indirect Processes. Materials science for Additive Manufacturing: Different materials used in AM, Role of solidification rate, Structure property relationship, Grain structure and microstructure. Additive Manufacturing Technologies: Powder-based AM processes, Printing processes (droplet based) 3D Solid-based AM processes, object Stereo lithography. Micro and Nano AM. Mathematical models in Additive Manufacturing: Transport phenomena models, Numerical Modeling of AM process, Powder bed melting based process, Droplet based printing process Residual stress, part fabrication time, cost and optimal orientation. Process Selection, planning and control of Additive Manufacturing: Selection of AM technologies using decision methods. Additive manufacturing process plan strategies and post processing. Defect in AM and role of transport. Monitoring and control of defects.

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.
2. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.
3. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, e-ISBN: 978-3-642- 28359-8.

4. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM) processes of titanium alloy, InTech, 2012.
5. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 2010.

MME 5011 ADVANCED METAL CASTING AND JOINING

Casting: Patterns, pattern allowances, mould and core making, melting practice and furnaces, cooling and solidification, Elements and design of gating system and risers, application of chills. Different moulding and casting processes, Casting defects, Fettling and testing of casting. Welding and Allied Processes: Classification, structure and characteristics of welding arc, arc welding power sources, duty cycle, metal transfer, Selection of Welding process. Different welding processes, Weld defects, Brazing and Soldering. Welding Metallurgy: Heat flow in welding, Metallurgical transformation in and around weld ment, Implication of cooling rates, Heat affected zone (HAZ), Weldability of steels, Design of weld ments, Destructive and Non-destructive tests of welding joints.

References:

1. H.S.Bawa, Manufacturing Technology-I, TMH Publications, New Delhi, 2007.
2. S.V.Nadkarni, Modern Arc Welding Technology, Oxford and IBH Publishing Co. Pvt. Ltd., 2010.
3. Serope Kalpakjian and Steven R. Schmid, Manufacturing Processes for Engineering Materials, 4th edition, Pearson Education, 2007.
4. P. L. Jain, Principles of Foundry Technology, 5th edition, 2009.
5. R. S. Parmar, Welding Processes and Technology, 3rd Edition, New Delhi, 2011.

MME 5012 ADVANCED HEAT TREATMENT [3 1 0 4]

Heat treatment related phase transformation reactions in iron –iron carbide phase diagram, lever rule application in binary steels and cast iron, alloying elements effect on austenite loop, austenite, ferrite stabilizers, carbide and graphite formers, kinetics, mechanism, influencing parameters on austenite formation, kinetics, mechanism, influencing parameters on isothermal diffusion and shear process controlled austenite transformation into room temperature structures and factors involved in transformation process, continuous cooling transformations. Heat treatment of steels and nonferrous metals involving phase transformation, change in chemical composition, deformation and combination, surface hardening, hardenability and its importance, heat treatment furnaces. Heat treatment and application of commercial steels, tool steels, stainless steels, cast iron, heat treatment and application of grey cast iron, white, malleable, spheroidal cast iron and alloy cast irons, special nonferrous alloys and composites, major heat treatment defects.

References:

1. T.V. Rajan, C P Sharma and Alok Sharma, Heat treatment principles and techniques, PHI Publication, Delhi 1999.
2. Vijendra Singh, Heat Treatment of Metals, Standard Publishers Distributors, Delhi, 1998.
3. ASM Handbook – Heat treating, Vol 4.
4. ASM Handbook – Alloy phase diagram (500s), Vol 3.
5. Romesh C Sharma, Principles of Heat Treatment of Steels, New Age International (P) Limited, New Delhi, 1996.

MME 5013 DESIGN FOR MANUFACTURING [3 1 0 4]

Phases of design, essential factors of design, design and manufacturing, advantages of DFMA in product design, selection of materials and processes. Characteristics and design guidelines for sand casting, investment casting, die-casting, investment moulding and forging. Characteristics and design guidelines for manufacture of sheet metal and powder metal parts with examples. Design for machining - characteristics and design guidelines for turning, drilling, reaming, shaping, slotting, milling, grinding, honing, lapping, super finishing and advanced machining processes. Characteristics of manufacturing process and design guidelines for plastics, rubbers, ceramics and glass components. Process engineering - designing for heat treatment, sequence of operations for manufacturing of round and flat type components. Dimensioning for manufacturing, Fits, tolerance and surface finish consideration in design, Preparation of manufacturing drawings of components of various products.

References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Product Design for Manufacture and Assembly, (3e), CRC Press, 2011.
2. James G. Brala, Design for Manufacturability Handbook, (2e), McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood, Product Design, Pearson Education, Delhi, 2001.
4. Chitale A. K. and Gupta R. C., Product Design and Manufacturing, PHI Pvt. Ltd., New Delhi, 2005.
5. Corrado Poli, Design for Manufacturing- A Structured Approach, Butterworth-Heinemann Ltd., 2001.

MME 5014 FRACTURE MECHANICS [3 1 0 4]

Fracture mechanics approach to design, brittle and ductile fracture, effect of material properties on fracture. Linear Elastic Fracture Mechanics- fracture modes, fracture criteria, mechanisms of fracture & crack growth, griffith's analysis, energy release rate (G), elastic crack tip fields, stress intensity factor, Crack tip plasticity -Irwin approach, strip yield model, plastic zone shape and size, plane strain fracture toughness. Elastic-Plastic Fracture Mechanics - J-integral, HRR fields, J-controlled crack growth, Crack tip opening displacement. Fracture toughness testing of metals - KIc test, JIc measurement, determination of critical CTOD. Fatigue Fracture Mechanics - Fatigue crack growth, crack closure and fatigue threshold, crack growth behavior under variable amplitude loading, effect of overload, prediction of fatigue crack growth and & life of a structural component. Fail safety and damage tolerance - damage tolerance approach of failsafe design, fracture safe design of thick & thin pressure vessels, leak before break, dynamic fracture mechanics, mixed mode fracture initiation and growth, Applications of fracture mechanics to engineering design, FEA of cracks in solids.

References:

1. Anderson T. L., Fracture Mechanics-Fundamentals and applications, (3e), CRC Press, London, 2005.
2. Richard W Hertzberg, Richard P Vinci and Jason L Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, (5e), John Wiley & Sons, 2012.
3. Broek D., The Practical Use of Fracture Mechanics, Springer Netherlands, 1989.

4. Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education Private Limited, 2013.
5. Norman E Dowling, Mechanical Behaviour of Materials, (4e), Prentice Hall, 2012.

MME 5015 MECHANICS OF COMPOSITE MATERIALS [3 1 0 4]

Importance of composite materials, overview, significance and characteristics of composite material, applications and developments, types and classification, Manufacturing of different types of composite materials, quality inspection methods, micro and macro mechanics of fiber reinforced lamina and macro mechanics of composite laminate, testing of composite materials, analysis of laminated composite beams, damage prediction, theories of failures for composite materials.

References:

1. Mallick. P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design (3e), CRC Press, 2007
2. B. D. Agarwal, L.J. Broutman, K. Chandrashekhara, Analysis and performance of fiber composites, Wiely, 2012
3. Robert M. Jones, Mechanics of Composite Materials (2e), Taylor & Francis, 2015
4. Michael W. Hyer, Stress analysis of fiber Reinforced Composite Materials, McGraw Hill Publication, 2014.
5. Kishan K. Chawla, Composite materials – Science and Engineering, Springer, 2012

OPEN ELECTIVES

MME 5053 CORROSION SCIENCE [3 0 0 3]

Definition of corrosion, Importance of corrosion study, Costs of corrosion, Corrosion environments, Corrosion damage, Classification of corrosion, Factors influencing corrosion rate. Uniform corrosion, Galvanic or two metal corrosion, Crevice corrosion, Pitting corrosion, Inter-granular corrosion, Selective leaching, Erosion corrosion, Stress corrosion, Hydrogen damage. Corrosion testing, Purpose, Materials and specimens, Surface preparation, measuring and weighing, Exposure techniques, Duration, Planned interval tests, Aeration, Cleaning specimens after exposure, Standard expressions for Corrosion rate. Corrosion prevention, Materials selection – Metals and alloys, Metal purification, non-metallics, Change of environments – Changing the medium, Use of Inhibitors, Design improvements, Cathodic and anodic protection, Coatings – metallic coating, inorganic coating, organic coating, failure analysis. Corrosion Principles, Electrochemical theory of corrosion, Applications of thermodynamics to corrosion, Free energy, activation energy, Polarization of corrosion reactions, Activation polarization, Concentration polarization, Combined polarization, Pourbaix diagram (E/pH diagram) passivity, Corrosion rate measurements – Tafel extrapolation and Liner polarization techniques

References:

1. Mars G. Fontana, Corrosion Engineering, Third edition Tata McGraw Hill, New Delhi.
2. Zaki Ahmed, Principles of Corrosion Engineering and Corrosion Control, Elsevier Science and Technology Books, 2006.
3. K. R. Trethewey and J. Chamberlain Longman, Corrosion for students of science and engineering, Scientific & Technical New York, USA.
4. Schweitzer Philip A, Fundamentals of Corrosion-Mechanisms, Causes and Preventive Methods, CRC Press, Tayler and Francis Group, Boca Raton, 2010.
5. Pierre R. Roberge, Corrosion Engineering – Principles and practices, Gulf publishing company.

MME 5054 CREATIVITY FOR PRODUCT DESIGN [3 0 0 3]

Introduction to Product Design - Product Design Process, design by innovation, creativity in design, strength considerations in product design. Tools for design: Information-based tools, Procedure-based tools, Quality Function Deployment, Taguchi technique for robust design, Design for Manufacture, Rapid prototyping; Embodiment design. Creative thinking - The five dimensions of creativity, synthesis, evolution, revolution, re-application and change, creative thinking tools for idea generation and problem solving, convergent and divergent, theory of inventive problem solving. Basic Probability concepts- Basic probability theory, Central Limit Theorem, probability mass function, cumulative distribution function, probability density function. Reliability of Components and Systems- reliability theory, reliability management, history of reliability engineering; reliability allocation, reliability testing.

References:

1. Ulrich Karl T. and Eppinger Steven D., Product Design and Development, McGraw Hill International Edition, 1999.
2. Rosenthal Stephen, Effective Product Design and Development, Business One Orwin Homewood, 1992.
3. Dieter, Engineering Design, McGraw Hill International Edition, 1990.
4. Day Ronald G., Quality Function Deployment, Tata McGraw Hill, 1990.
5. Goldenberg and Mazursky, Creativity in Product Innovation, Cambridge University Press, 1996.

MME 5055 DESIGN OF EXPERIMENTS [3 0 0 3]

Understanding basic design principles, Working in simple comparative experimental contexts, introduction to R language and its applications in DOE problems, Working with single factors or one-way ANOVA in completely randomized experimental design contexts, Implementing randomized blocks, Latin square designs and extensions of these, Understanding factorial design contexts, Working with two level, 2k, designs, Implementing confounding and blocking in 2k designs, Working with 2-level fractional factorial designs, Working with 3-level and mixed-level factorials and fractional factorial designs, Simple linear regression models, Understanding and implementing response surface methodologies, Understanding robust parameter designs, Working with random and mixed effects models, Design of computer experiments and the applications in industrial engineering problems.

References:

1. Montgomery, D. C. (2001), Design and Analysis of Experiments, John Wiley & Sons. Inc. ISBN: 0-471-31649-0.
2. Dean, A. M. and Voss, D. T. (1999), Design and Analysis of Experiments (Springer text in Statistics), Springer Science + Business Media, Inc. ISBN: 0-387-98561-1.
3. Box, G. E. P., Hunter, W. G., and Hunter, J. S. (1978), Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building, John Wiley & Sons. Inc. ISBN: 0-471-09315-7.

4. Diamond, W. J. (2001), Practical Experiment Designs for Engineers and Scientists, John Wiley & Sons. Inc. ISBN: 0-471-39054-2.
5. Jeff Wu, C. E. and Hamada, M. I. (2000), Experiments: Planning, Analysis, and Parameter Design Optimization, John Wiley & Sons. Inc. ISBN: 0-471-39054-2.

MME 5057 INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]

Industrial revolution; Milestones in the safety movement; Accidents & their effects; Cost of accidents; Theories of accident causation - Domino theory, Human factor theory, Accident/incident theory, Epidemiological theory, System theory, Industrial Hazards Ergonomic Hazards; Mechanical Hazards; Fall and impact hazards; Temperature hazards; National Safety Council India (NSCI) and Industrial Safety Acts: Introduction to NSCI; Mission and Vision; Milestones; Management; NSCI safety award schemes; Safety audits; Risk assessment; NSCI safety rating system; Hazard and operational (HAZOP) studies, Industrial Safety Analysis and Management, Preliminary hazard analysis; Detailed hazard analysis; Failure mode and effect analysis (FMEA); Human error analysis (HEA); Environmental Safety: Safety, health and environment.

References:

1. David L. Goetsch, Occupational Safety and Health for Technologists, Engineers and Managers, 5th Edition, Pearson-Prentice Hall, 2005.
2. Frank R. Spellman and Nancy E. Whiting, The Handbook of Safety Engineering: Principles and Applications, The Scarecrow Press Inc., 2010
3. Amit Kumar Gupta, Industrial Safety and Environment, Laxmi Publications (P) Ltd., 2006
4. National Safety Council India, "NSC," [Online]. Available: http://nsc.org.in/.
5. Ministry of Labour and Employment, "Ministry of Labour and Employment," [Online]. Available: http://nsc.org.in/.

MME 5058 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. Chasel Aquilino, Productions and Operations Management, Dreamtech latest edition.
2. Yasuhiro Monden , Toyoto Production System -An integrated approach to Just in Time, Engineeringaild Management Press - Institute of Industrial Engineers Norcross Georgia, 1983.
3. James P Womack - Daniel T Jones- and Daniel Roos, The Machine that changed the World. The Story of Lean Production - -Harper Perennial - edition published, 1991.
4. James Womack, Lean Thinking - ISBN 0743249275, 2003.
5. Richard Schourberger, Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - ASQC Press, 1991.

MME 5059 RENEWABLE ENERGY TECHNOLOGY [3 0 0 3]

Solar energy –Production and transfer of solar energy – Sun-Earth angles –Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation. Applications of Solar energy, Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels, Aerobic and anaerobic bio-conversion – Properties of biomass, Biogas plants– Design and operation, Wind energy – Principles of wind energy conversion – Site selection considerations –Wind power plant design – Types of wind power conversion systems – Operation, maintenance and economics, fuel cells, fuel cell power plant, Geothermal fields- Hot dry rock, Energy conversion technologies, Ocean thermal energy conversion, Wave and tidal energy: Scope and economics – Introduction to integrated energy systems.

References:

1. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994.
2. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
3. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
4. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
5. H.P. Garg, S.C. Mullick and A.K. Bhargava: Solar Thermal Energy Storage, 1985
6. K.M. Mittal: Non-conventional Energy Systems-Principles, Progress and Prospects, Wheeler Publications, 1997.

Department of Mechatronics Engineering

Mechatronics is a multidisciplinary field of Engineering with a rich knowledge base formed by various disciplines of Engineering. Hence an integrated curriculum is designed to provide a broad based education in the basic principles of Electrical, Electronics, Computing, Mechanical and Control Systems. Such a varied and diverse program is gaining much recognition and importance with every passing day and has become an engineering discipline high on demand. The main objective of the department is to enable students with the potential to address challenges which are interdisciplinary in nature by laying a strong foundation of multidisciplinary knowledge in their intellect.

The department is well equipped with laboratories set up in collaboration with Bosh Rexroth India Pvt. Ltd which includes some of the finest automation equipment like, Modular Production Systems, Hydraulics and Pneumatics, Programmable Logic Controllers, Drives and control, sensorics and robotics lab. The main objective of this industry-academic partnership initiative is to transfer current technology to the students and to bridge the technology gap that exists between industry and academic. The necessity of a seamless integration of different disciplines has been effectively managed by a multidisciplinary team of young, dynamic and well-motivated faculty.

Programs offered

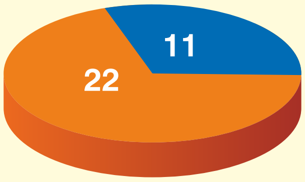
Under Graduate Program
- B.Tech in Mechatronics (2006)

Post Graduate Program
- M.Tech in Industrial Automation & Robotics (2015)

PhD

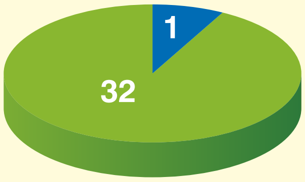
Faculty Strength

Qualification-wise

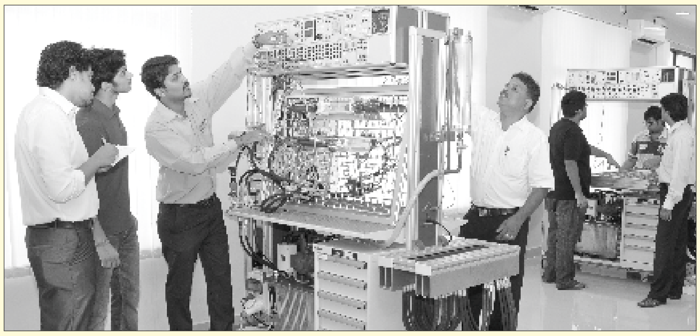


- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Assistant Professors



DEPARTMENT OF MECHATRONICS, MIT Manipal

M.Tech. INDUSTRIAL AUTOMATION AND ROBOTICS

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5162	Mathematics for Simulation and Modelling	4	0	0	4	MTE 5251	Embedded Systems for Automation	3	0	3	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	MTE 5252	Fluid Power Systems and Factory Automation	3	0	0	3
	MTE 5151	Robot Kinematics and Dynamics	4	0	0	4	MTE 5253	Motion Control and Path Planning	3	0	0	3
	MTE 5152	Sensors, Drives and Actuators for Industrial Automation	4	0	0	4	MTE ****	Elective III	4	0	0	4
	MTE ****	Elective I	4	0	0	4	MTE ****	Elective IV	4	0	0	4
	MTE ****	Elective II	4	0	0	4	*** ****	Open Elective	3	0	0	3
	MTE 5161	Drives and Controls Lab	0	0	6	2	MTE 5261	Hydraulics and Pneumatics Lab	0	0	6	2
	MTE 5162	PLC and Modular Production Systems Lab	0	0	3	1	MTE 5262	IIOT Lab	0	0	3	1
							MTE 5263	Robotics Lab	0	0	3	1
		Total	**21**	**0**	**12**	**25**		**Total**	**20**	**0**	**15**	**25**
	THIRD AND FOURTH SEMESTER											
II	MTE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
MTE 5001	Analog and Digital Electronics	MTE 5006	Machines and Mechanisms
MTE 5002	Artificial Intelligence and Expert Systems	MTE 5007	Micro-Manufacturing Systems
MTE 5003	Automated Manufacturing Systems	MTE 5008	Signal Processing and Applications
MTE 5004	Digital Manufacturing	MTE 5009	Wireless Sensor Networks
MTE 5005	Machine Vision and Image Processing		

OPEN ELECTIVES			
MTE 5051	Advanced Control Systems	MTE 5053	Integrated Product Development
MTE 5052	Design Aspects of Industrial Automation	MTE 5054	Machine Learning

SEMESTER I

MAT 5162 MATHEMATICS FOR SIMULATION AND MODELLING [4 0 0 4]

Principles, Definitions of Mathematical Modelling and Simulation, State and System Parameters, Case studies: Modelling of inverted pendulum on moving cart. Basic theory, independence, Bayesian networks and other graph-theoretical models, Interference with Bayesian networks, Markov random fields, Matrix Representation of graphs – Incident matrix, Adjacency matrix, cycle matrix, cutset matrix, path matrix, Digraphs D, Matrix - tree theorem on number of spanning trees. Tournament. Directed Circuits and Shortest paths, Solution of linear and nonlinear system of equations: Direct methods – Gauss Jordon method, Crouts (LU decomposition) method, Cholesky Decomposition method and Thomas Algorithm for tridiagonal systems. Indirect Methods (Iterative methods) – Gauss Seidal and successive over relaxation. Newton Raphson method (system of non-linear equation), Birgevieta method, Bairstow's method, Eigen values and Eigen vectors using Power method. Concept of Finite Difference Method and Finite Element Method. Convex set, nonlinear constrained optimization: definition, basic concept, Lagrange Multipliers method, Kuhn-tucker theorem; Nonlinear unconstrained optimization: definition, basic concept, Steepest Descent method, Steepest Ascent method, Conjugate Gradient method, variable matrix method.

References:

1. Nielsen, Thomas Dyhre, and Finn Verner Jensen. Bayesian networks and decision graphs. Springer Science & Business Media, 2009.
2. Katsuhiko Ogata, "Modern control engineering" Prentice-Hall, 2002
3. Rao S.S., 'Optimization: theory and Practice', Wiley Eastern Limited, 2005.
4. Jain, Mahinder Kumar. Numerical methods for scientific and engineering computation. New Age International, 2003.
5. J. N. Kapur, "Mathematical Modelling", Wiley Estern, 1998.

MTE 5152 SENSORS, DRIVES AND ACTUATORS FOR INDUSTRIAL AUTOMATION [4 0 0 4]

Data acquisition, signals conditioning, Sensors and transducers, Static characteristics, selection criteria, Units of measurements. Working Principle, operation, and applications of industrial sensors smart sensing, automation gadget sensors Actuators – Principle of operation of actuators, fundamental laws, classification, different types of motors and construction, torque- speed characteristics, applications, merits and demerits. Fundamentals of Electric drives - Components of electric drives, factors affecting choice of drives, fundamental torque equation, speed-torque conventions, steady state stability, multi-quadrant operation of electric drives, load torque components, load equalization, determination of motor power rating, motor duty cycles, electric braking, modes of operation, speed control and drive classification, closed loop control of drives, digital control. Power electronics – Power flow control switching, power electronic devices, power MOSFET, power BJT, SCR, V- I, turn on, turn off characteristics, triggering methods, PWM methods. DC drives- DC motor control, speed control, position control, proportional control, PID controllers. AC drives- Induction motor drives, synchronous motor drives, stepper motor drives, BLDC drivers, PMAC drivers, switched reluctance motors drives.

References:

1. A.K.Sawhney ,"A course in Electrical and Electronic measurements and instrumentation" Dhanpat Rai & Co.Publication, 2015.
2. Jacob Frden "AIP Handbook of modern sensors, physics, design and applications"American Institute of Physics-New York, 1993.
3. W.Bolton, "Mechatronics-Electronic control systems in mechanical and electrical engineering" Pearson Fourth edition, 2011.
4. Bimbra P.S., "Power electronics", 3/e, Khanna Publishers, 2003.
5. J.B.Gupta."A ourse in electrical technology"S.K.Kataria & sons, 2012.

MTE 5151 ROBOT KINEMATICS AND DYNAMICS [4 0 0 4]

Introduction to robotics- types and specification of robots, DoF, configurations, control resolution, spatial resolution, accuracy and repeatability, actuators and sensors, drives and transmission systems used in robotics. Kinematic analysis & coordinate transformation-Direct kinematic problem in robotics, homogeneous transformation matrices, joint space, and cartesian space, Denavit-Hartenberg method, Inverse manipulator kinematics solvability, robot kinematics constraints, robot workspace, holonomic robots, Jacobian matrix, Jacobian singularity. Trajectory generation- general considerations in path description and generation, joint-space schemes, cartesian-space schemes. Manipulator dynamics-Newton's equation, Euler's dynamic formulation, iterative vs. closed form. Mobile robot planning & navigation- Introduction, competences for navigation-planning & reacting, obstacle avoidance. Navigation architectures-modularity for code reuse & sharing, control localization, techniques for decomposition. Case studies.

References:

1. Lynch, Kevin M. "Modern Robotics-Mechanics, Planning, and Control": Video supplements and software." (2017).
2. Murray, Richard M. "A mathematical introduction to robotic manipulation". CRC press, 2017.
3. Craig, John J. "Introduction to robotics: mechanics and control". Vol. 3. Upper Saddle River, NJ, USA: Pearson/Prentice Hall, 2005.
4. Niku, Saeed. "Introduction to robotics". John Wiley & Sons, 2010.
5. Mittal, R. K., and I. J. Nagrath. "Robotics and control". Tata McGraw-Hill, 2003.

HUM 5151 RESEARCH ME THODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of research methodology: basic concepts: types of research, significance of research, research framework case study method, experimental method, sources of data, data collection using questionnaire, interviewing, and experimentation. Research formulation: components, selection and formulation of a research problem, objectives of formulation, and criteria of a good research problem. Research hypothesis: criterion for hypothesis construction, nature of hypothesis, need for having a working hypothesis, characteristics and types of hypothesis, procedure for hypothesis testing; sampling methods: introduction to various sampling methods and their applications. Data analysis: sources of data, collection of data, measurement and scaling technique, and different techniques of data analysis. Thesis writing and journal publication: writing thesis, writing journal and conference papers, IEEE and Harvard styles of referencing, effective presentation, copyrights, and avoiding plagiarism.

References:

1. Dr. Ranjit Kumar, "Research Methodology; A Step-by-Step Guide for Beginners",SAGE. 2005.
2. Geoffrey R. Marczyk, David De Matteo& David Festinger, "Essentials of Research Design and Methodology", John Wiley &Sons, 2004.
3. John W. Creswel, "Research Design: Qualitative, Quantitative, and Mixed Methods approaches", SAGE. 2004.
4. Suresh C. Sinha and Anil K. Dhiman, "Research Methodology (2Vols-Set)", Vedam Books., 2006.
5. C. R. Kothari, "Research Methodology; Methods & Techniques",new age international publishers, New Delhi., 2008.

MTE 5162 PLC & MODULAR PRODUCTION SYSTEMS LAB [0 0 3 1]

Introduction of PLC, study of basic components, networking and different programming technique of PLC. Study of NO, NC and holding circuit programs, Implement of Simple Ladder program, to study basic functions of timers, counters, math, logical and program control instructions. Study different applications using ladder logic. Study hardware and software used in particular vendor PLC, develop a ladder program and implementation of distribution, process, handling, separating and buffer stations.

Introduction to the Mechatronics and Modular Production Systems(MPS), Brief study and understanding of Distribution station, Buffer station, Processing station, Handling station and Storage station along with demonstration and hands on experiment with PLC.

References:

1. Mechatronics training practice module, FESTO manual Germany 2011.
2. Drives and Control training system practice module, BOSCH REXROTH manual Germany 2011
3. PLC training practice module,BOSCH REXROTHmanual Germany 2011
4. John W. Webb and Ronald A. Reiss, Programmable logic controllers-Principle and applications, (5e), PHI.
5. Hackworth and Hackworth F.D, Programmable logic controllers-Programming Method and applications, Pearson, 2004.

MTE 5161 DRIVES AND CONTROLS LAB [0 0 6 2]

Automation motors and their drivers and controls: Stepper motors, servo motors, linear motors etc. Configuring masters and slaves, synchronizing master & slave, making drives PLC enabled, restructuring encoders, running motors in translation and rotation mode, position & velocity control, PLC programming – pick and place operation, tracing drive parameters.

References:

1. Drives and Control training system practice module, BOSCH REXROTH manual Germany 2011
2. PLC training practice module,BOSCH REXROTHmanual Germany 2011
3. John W. Webb and Ronald A. Reiss, Programmable logic controllers-Principle and applications, (5e), PHI.
4. Hackworth and Hackworth F.D, Programmable logic controllers-Programming Method and applications, Pearson, 2004.

SEMESTER II

MTE 5252 FLUID POWER SYSTEMS AND FACTORY AUTOMATION [3 0 0 3]

Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-drive characteristics. Linear actuator - types, mounting details, cushioning - power packs - construction. Reservoir capacity, heat dissipation, accumulators - standard circuit symbols, circuit (flow) analysis. Direction flow and pressure control valves-methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and under lapped spool valves-operating characteristics- electro hydraulic system, electro hydraulic servo valves-different types characteristics and performance. Types of proportional control devices- pressure relief, flow control, direction control, hydraulic symbols, spool configurations, selection & sizing with reference to manufacturer's data, electrical operation, basic electrical circuits and operation, solenoid design, comparison between conventional and proportional valves. Typical industrial hydraulic circuits-design methodology. Example: paper industry, process industry, printing sawmill, woodworking, extrusion press, powder methodology press, continuous casting, food and packaging, injection moulding, solar energy and automobile.

References:

1. Antony Esposito, Fluid Power with Applications, 7th edition, Pearson Prentice Hall, 2013
2. S. Ilango, V. Soundararajan, Introduction to Hydraulics and Pneumatics, 2nd edition, PHI Learning, 2011.
3. R.SrinivasanHydraulic and Pneumatic Control, 3rd edition, published by Vijay Nicole Imprints Private Ltd. 2004
4. Shizurou Konami, Takao Nishiumi, Hydraulic control systems: Theory and Practice , World Scientific Publishing, 2017.

MTE 5251 EMBEDDED SYSTEMS FOR AUTOMATION [3 0 3 4]

Basic controller and processor – architecture and philosophy, Introduction to datatypes and variables, RISC and CISC – instruction set, architecture. Introduction to arm, processor architecture and organization, RISC and arm design philosophy, embedded system hardware, embedded system software, arm processor fundamentals, arm processor fundamentals, exceptions, interrupts and vector table, developmental tools, core extensions, arm processor families, arm 3 stage and 5 stage pipelining, instruction set, data processing instruction , FPGA & CPLD Architectures - FPGA Programming Technologies- FPGA Logic Cell Structures- FPGA Programmable Interconnect and I/O Ports - FPGA Implementation of Combinational Circuits - FPGA Sequential Circuits - Timing Issues in FPGA Synchronous Circuits, Real time operating systems based embedded system design, operating system basics, types of operating systems, multi-processing and multi-tasking, task scheduling-non pre-emptive and pre-emptive scheduling with examples, Design considerations, interfacing mixed signal circuits and sensors, EMI/EMC considerations, PCB layout guidelines, characteristics and quality attributes of embedded systems, examples of time-critical and safety-critical embedded system, applications in automation- automotive – aerospace - medical and manufacturing.

References:

1. K.J. Ayala,Dhananjay V. Gadre "The 8051 Microcontroller and Embedded systems", *CENGAGE Learning,2010*
2. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, "8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2010.
3. Shibu K.V, "Introduction to Embedded sytems," *McGraw Hill, 2009*
4. Frank Vahid, Tony architectureGivargis " Embedded Systems", *Wiley India Edition, 2002*

MTE 5253 MOTION CONTROL AND PATH PLANNING [3 0 0 3]

Introduction: Classification of Robot (fixed, mobile), fixed- serial, parallel, Hybrid. Mobile-Ground (wheeled (omnidirectional, holonomic), tracked, legged), under water (submarine, fishlike), Surface (Ship like) and Aerial (Fixed wing, flapping wing, rotor based). Overview of motion planning, Configuration space, Degree of freedom, Definition, Introduction to Trajectory planning, General consideration in path description and Generation of motion, Joint space motions, Cartesian space motions, Point to point: Straight line path, Trapezoidal motion profile and S curve motion, Polynomial via point Trajectories. Application: Two axis /three axis planar mechanism Trajectory planning.Wheeled robots - over view of path planning, Algorithms - Analysis and complexity, running time, complexity, completeness.

Visibility graph, Road Maps - Generalized Voronoi Graph (GVG) - definition, properties, Cell Decompostion – Trapezoidal decomposition, Morse cell decomposition - variable slice, sensor based coverage, complexity coverage, Visibility based decomposition. Control based planning, Manipulation planning, Optimal motion planning, Feedback motion planning, Randomised Kinodynamic Planning, Legged robots- Introduction, locomotion - key issues for locomotion, legged mobile robots, leg configurations & stability, Gait analysis, examples of legged robot locomotion. Case studies.

References:

1. H. Choset, K. M. Lynch, "Principles of Robot Motion: Theory, Algorithms, and Implementations", 1/e, MIT Press, Boston, 2005.
2. Planning Algorithms, "Steven M. LaValle", 1/e, Cambridge University Press, 2006.
3. Farbod Fahimi –"Autonomous Robots- Modeling, Path Planning, and Control", 1/e Springer, 2009.

MTE 5261 HYDRAULICS AND PNEUMATICS LAB [0 0 6 2]

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, pressure switch, pressure reducing valve, accumulator, proximity switch, throttle valves, pressure compensated flow control valves and direction control valves. Rigging of manual and electro hydraulic circuits using above components.

References:

1. Practice for Professional Pneumatics Trainee's manual, BOSCH REXROTH manual Germany 2011
2. Practice for Professional Electro-Pneumatics Trainee's manual, BOSCH REXROTH manual Germany 2011.
3. Industrial Hydraulics Trainee's manual, BOSCH REXROTH manual Germany 2011.

MTE 5262: IIOT LAB [0 0 3 1]

Operation of TwinCAT software, tools and usage. I/O accessing: Analog and Digital detection of sensors. Actuation on sensor detection using TwinCAT. HMI programming using TwinCAT. ADS communication in LAN. Actuation and programming of stepper and servo motors using TwinCAT. Communication using OPCUA with remote server. Creation of apps for usage and remote control of factory floor.

References:

1. Beckhoff: New Automation Technology: Main Catalog, Volume 1, IPC, Motion, Automation,Germany, 2018.
2. Beckhoff: New Automation Technology: Main Catalog, Volume 2, I/O, Germany, 2018.

MTE 5263 ROBOTICS LAB [0 0 3 1]

Programming and control of multi--axis robot, part recognition using robotic vision system, path and trajectory planning of multi-axis robotic manipulator. Building of Robotic manipulator by using stepper and servo drives. Implementation of sensors and control algorithms in robotic manipulators.

References:

1. John J. Craig, *Introduction to Robotics- Mechanics and Control, (3e)*, Pearson Education International, 2004.
2. YoramKoren, *Robotics for Engineers*, McGraw Hill, 1992

SEMESTER III & IV

MTE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

MTE 5001 ANALOG AND DIGITAL ELECTRONICS [4 0 0 4]

Analog Circuits- Diode circuits, Transistors, Linear and non-linear applications of Operational amplifiers with positive and negative feedback. Special functions-ADC, DAC, IC555 Timer, Voltage regulator IC's 78XX & 79XX series - adjustable output voltage regulator LM 317. Number system, codes and combinational logic- BCD numbers (8421-2421), different binary codes and conversion, ASCII, EBCDIC codes, combinational circuits. Flip flop and timing circuit- Latches and different types of flip flops. Registers & counters- types and applications of counter, shift register, bi-directional register.

References:

1. Ananda Kumar, *"Switching Theory and Logic Design",* Prentice Hall of India, 2009.
2. R.L.Boylestad, L.Nashelsky, "Electronic Devices and Circuit Theory", PHI 8th edition. 2003.
3. Ramakant, Gayakwad. "Op-amps and linear integrated circuits." 4thEdition, PHI publication Lecture Laboratory 02perbatch Tutorial--- Hours Marks Hours Marks (2000).
4. Roy, D. Choudhury. Linear integrated circuits. New Age International, 2003.

MTE 5002 ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS [4 0 0 4]

Artificial intelligence-Overview and Historical Perspective, Applications in various domains.

Statistical and Probabilistic Reasoning- Symbolic reasoning under uncertainly, probability and Bayes' theorem, certainty factors and rule based systems, Linear Discrimination, Bayesian networks and Decision Theory, Dempster – Shafer theory. Machine learning- Introduction, regression and clustering, K-means algorithm, Hierarchical and Association Learning for Clustering, Support vector machines, Naïve Bayes, Decision Trees and Random Forest. Optimization Techniques- Introduction to optimization, Traditional optimization techniques with applications. Fuzzy Logic Systems-Crisp sets and relations, Fuzzy sets and relations. Fuzzy rule based systems, de-fuzzifications methods and applications. Knowledge, Reasoning and Planning-Logical Agents, Fundamental and Inference of First-Order Logic, Classical Planning, Knowledge Representation and Reinforcement Learning. Artificial Neural Network-Introduction, McCulloch-Pitts Neuron Model, Models of

Artificial Neural Network, Learning and Adaption, Learning Rules, Winner-Take-All, Multilayer feedforward, Feedback Networks and Associative Memories.

References:

1. Khemani, Deepak. A first course in artificial intelligence. McGraw-Hill Education, 2013.
2. Rajasekaran, Sanguthevar, and GA Vijayalakshmi Pai. Neural networks, fuzzy logic and genetic algorithm: synthesis and applications (with cd). PHI Learning Pvt. Ltd., 2003.
3. Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited, 2016.

MTE 5003 AUTOMATED MANUFACTURING SYSTEMS [4 0 0 4]

Development in machine tools, design consideration of CNC machines, control loops of CNC.Machine control unit - elements and their functions, principles, types and Stages of interpolation, requirements of interpolation algorithms, software interpolators. Tool path generation and control methods, CNC programming for turning and milling center by manual method, adaptive control machining system, automated inspection and testing, analysis of material transport systems, engineering analysis of automated storage systems.Methods of improving machine accuracy and productivity, automatic identification and data capture, RFID in manufacturing, part classification and coding, production flow analysis, computer integrated manufacturing system, flexible manufacturing system, computer aided process planning, shop floor control.

References:

1. Koren Yoram and Ben and Uri Joseph, “Numerical Control of Machine Tools”, Khanna Publishers, New Delhi, 2005.
2. GrooverMikell P., “Automation, Production Systems, and computer Integrated manufacturing” Prenice Hall of India, New Delhi., 2003.
3. Groover Mikell P. and Zimmers Emory W.,“Computer aided design and manufacturing” Prentice Hall of India , New Delhi., 2003.
4. Radhakrishnan P., “Computer Numerical Control Machines” New Central Book Agency (P) Ltd.,Kolkata., 2004.

MTE 5004 DIGITAL MANUFACTURING [4 0 0 4]

Introduction to manufacturing and web based manufacturing system-building blocks of automation, mechanization of parts handling, manufacturing systems, batch, mass, group, cellular systems, process planning and CAPP**,** computer network for manufacturing- integration of design and manufacturing, design assignment and practice based on process planning and CAPP.MEMS overview and working, design and manufacturing of electromechanical systems, application of MEMS, concurrent engineering- teamwork; interfacing of manufacturing and design, design for manufacturability; project management; design for assembly. Rapid manufacturing and prototyping technologies- generic process of product development, prototype tooling - process comparison, virtual prototyping, product architecture,design for manufacturing- industrial design and design for manufacturing, considerations, activity based costing; networking technologies.

References:

1. Syan, Chanan S., and Unny Menon, eds. Concurrent engineering: concepts, implementation and practice. Springer Science & Business Media, 2012.
2. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raju. Cad/cam/cim. New Age International, 2008.
3. Tai Ran Hsu, MEMS and Microsystems- Design and manufacturing, Tata McGraw Hill, 2001.
4. Marc J. Madou, Fundamentals of microfabrication,2002.
5. Jerome H Fuchs, The illustrated handbook of Advanced Manufacturing methods, 2002.

MTE 5005 MACHINE VISION AND IMAGE PROCESSING [4 0 0 4]

Image acquisition and pre-processing: Vision and image sensors, vision system components, image digitization, image formats, image representation, and histogram. Color space, image analysis coding and representation of regions, dimensional analysis, Pixel brightness transformations, image de-nosing, image enhancement, visual image quality indexes, edge detection and morphological operations. Image segmentation and feature extraction-Manual threshold and optimal thresholding, splitting and merging, segmentation quality indexes, Feature extraction of images, Fourier transformations, discrete cosine transform. Motion estimation and object recognition-Optical flow estimation, object tracking with Kalman filtering, Classification principles, cluster analysis, k-mean and fuzzy c-means, and optimization techniques in recognition. 3D vision-Parallel and Perspective projection geometry, pinhole camera model, lens distortion, affine and metric geometry, geometrical transformations, camera parameters, calibration methods, stereovision, epipolar geometry, triangulation, stereo correspondence algorithms, 3d reconstruction. Case studies/application.

References:

1. 1. Sonka, Milan, Vaclav Hlavac, and Roger Boyle. Image processing, analysis, and machine vision. Cengage Learning, 2014.
2. Cyganek, Boguslaw, and J. Paul Siebert. An introduction to 3D computer vision techniques and algorithms. John Wiley & Sons, 2011.
3. Gonzalez, Rafael C., and Richard E. Woods. "Digital Image Processing, New Jersey." (2002): 626.
4. Davies, E. Roy. Machine vision: theory, algorithms, practicalities. Elsevier, 2004.
5. Jain, Ramesh, Rangachar Kasturi, and Brian G. Schunck. Machine vision. Vol. 5. New York: McGraw-Hill, 1995.

MTE 5006 MACHINES AND MECHANISMS [4 0 0 4]

Kinematic pairs, Kinematic diagram and inversions. Mobility and range of movements. Displacement, velocity and acceleration analysis of planar linkages, analytical methods. Dimensional synthesis for motion, function and path generation. Force analysis of planar mechanisms. Inertia forces and their balancing for rotating machines. Gyro-dynamics and effects on machines. Conveyors- types and applications, Bearings-types and applications. Gear types, selection and application, gear trains including compound epicyclic gears.

References:

1. Norton, Robert L. Design of machinery: an introduction to the synthesis and analysis of mechanisms and machines. 5/ed, McGraw-Hill, 2011.
2. Uicker, John Joseph, Gordon R. Pennock, and Joseph Edward Shigley. Theory of machines and mechanisms. Vol. 1. New York, NY: Oxford University Press, 2011..
3. Myszka, David H. Machines and mechanisms.Applied Kinematic Analysis. 4/e, Pearson Higher education, 2012.

MTE 5007 MICRO-MANUFACTURING SYSTEMS [4 0 0 4]

Introduction, working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nanomanufacturing, industrial applications and future scope of micro-manufacturing processes. Different instruments related to micro manufacturing such as microsensors, microactuators, microsystems. Working principles, machine construction, and applications of micromachining, nanofinishing, microjoining, microforming, microcasting, 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.

MTE 5008 SIGNAL PROCESSING AND APPLICATIONS [4 0 0 4]

Fundamentals of signals and system-Introduction to signals, systems and its applications, Signal and systems classification, properties and operations, Impulse response of the system. Signal transformation and analysis-Z-transform, region of convergence, Inverse z transform, transfer function, poles and zeros, application of z transforms to discrete time systems, Sampling and aliasing. Frequency domain analysis of discrete time signals, Discrete Fourier transform (DFT), properties of DFT, linear convolution using DFT, Fast Fourier Transform. Filters-Introduction to filter, Finite Impulse Response (FIR), Infinite Impulse Response (IIR), Filter structures, Direct form I, II, Cascaded form, Lattice form. Problem solving/ Real time application of Signal processing-Image signal processing, Moving image (video) signal processing, Audio signal processing, Communication signal processing, Temperature signal processing.

References:

1. Simon Haykin, Barry Van Veen, Signals and systems, (2e), John Wiley & Sons, 2007.
2. Proakis J.G. and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, (3e), PHI, 2007.
3. Oppenheim A.V. and R.W. Schafer, Discrete Time Signal Processing, (2e), Prentice-Hall, 2001.
4. Rabiner L.R and Gold D.J, Theory and Applications of Digital Signal Processing, Prentice Hall, 2007.
5. Mark Owen, “Practical Signal Processing”, Cambridge University Press, 2007.

MTE 5009 WIRELESS SENSOR NETWORKS [4 0 0 4]

Challenges for wireless sensor networks, single node architecture , hardware components, energy consumption of sensor nodes, network architecture, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, wireless channel and communication fundamentals, frequency allocation, modulation and demodulation, MAC protocols , contention-based protocols, SMAC – BMAC, TRAMA, IEEE 802.15.4 MAC protocol, Q-MAC (Querry MAC), Q-MAC (QoS MAC). Routing challenges and design, SPIN COUGAR, ACQUIRE, LEACH, PEGASIS, GF, GAF, GEAR, aggregation techniques – TAG, tiny DB traditional transport control protocols. Wireless LANs: 802.11, 802.11a/b/g, 802.16-WiMAX, UWB communications, wireless personal area networks, BlueTooth, healthcare monitoring system using wireless sensor networks, remote home lighting and appliance control system, automatic speed control and vehicle tracking using GSM and GPS technologies.

References:

1. KazemSohraby, Daniel Minoli and TaiebZnati, “Wireless Sensor Networks Technology- Protocols and Applications”, John Wiley & Sons, 2007.
2. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, Ltd, 2005.
3. Swami, Ananthram, et al., eds. Wireless sensor networks: signal processing and communications perspectives. John Wiley & Sons, 2007.
4. Murthy, C. Siva Ram, and B. S. Manoj. Ad hoc wireless networkd: Architestures and protocols. Pearson Education India, 2006.

OPEN ELECTIVES

MTE 5051 ADVANCED CONTROL SYSTEMS [3 0 0 3]

Introduction, Control structures and performance measures, Time and frequency domain performance measures, Design of controller, Design of controller for SISO system, Controller design for TITO processes, Limitations of PID controllers, PI-PD controller for SISO system, PID-P controller for Two Input Two Output system, Effects of measurement noise and load**.** Identification of dynamic models of plants, Relay control system for identification, Off-line identification of process dynamics, On-line identification of plant dynamics. State space based identification, State space analysis of systems, State space based identification of systems-1, State space based identification of systems -2, Identification of simple systems, Identification of FOPDT model 1 7 Identification of second order plus dead time model 1 8 Identification of SOPDT model 1 9 Steady state gain from asymmetrical relay test 1 10 Identification of SOPDT model with pole multiplicity.

References:

1. Ogata, Katsuhiko, and Yanjuan Yang. Modern control engineering. Vol. 4. India: Prentice hall, 2002.
2. Dorf, Richard C., and Robert H. Bishop. Modern control systems. Pearson, 2011.
3. Gopal, Madan. Control systems: principles and design. Tata McGraw-Hill Education, 2002.

MTE 5052 DESIGN ASPECTS OF INDUSTRIAL AUTOMATION [3 0 0 3]

Detailed study of P&ID, preparation of input / output list, listing of process range, list of instruments for hardwired control, list of field instruments. Preparation of specification sheets choosing of instruments, system study - examples categorization of operations, categorization of devices, deducing alarm limits, categorization of hard / soft alarms, categorization of input / output signals. Preparation of schemes, open loop schemes, closed loop schemes, power supply distribution schemes, hardwired control schemes, measurement schemes, marshalling schemes interface schemes, overview of input / output signal ranges, voltage input / output, current input / output, and pulse input RTD input, thermocouple input. power supply design, power requirements calculation, redundancy in power supply schemes, choice of circuit breakers - inrush current, interrogation power supply for inputs / outputs, panels & control desks, buffer termination / marshalling cabinets, power supply distribution in panels, control desks / panels, PLC/DCS panels.

References:

1. Terry Bartlet,"Industrial Control Electronics Devices, Systems, & Applications" 3rded, Delmar, 2006.
2. C. D. Johnson, "Process Control Instrumentation Technology" , Prentice Hall, 2002.
3. J. W. Webb and R. A. Reis, "Programmable Logic Controllers: Principles & Applications", Prentice Hall, 2002.
4. A D Srinivasan, D Michael Mcfarland**,** Smart structures analysis and design Cambridge univ press, 2000.

MTE 5053 INTEGRATED PRODUCT DEVELOPMENT [3 0 0 3]

Trend Analysis and Product Decision, Product Development methodologies – types of Product Development and Product Development life cycle – planning and management. Introduction to development process taxonomy (DPT), the front end process, adaptive generic product development process, Product Planning and steps for evolution – concept selection, concept testing, product architecture. Introduction to reverse engineering and value engineering, reverse engineering vs machine design, material identification techniques and process verification, geographical forms, Robust design & steps in design process, formulating objectives, development of experimental plan, methodologies of reflect and repeat, case study 1, case study 2, and case study 3. Engineering series industry, product development in industries vs institutions, Integration of mechanical, embedded & software systems, Intellectual property rights & confidentiality, security management.

References:

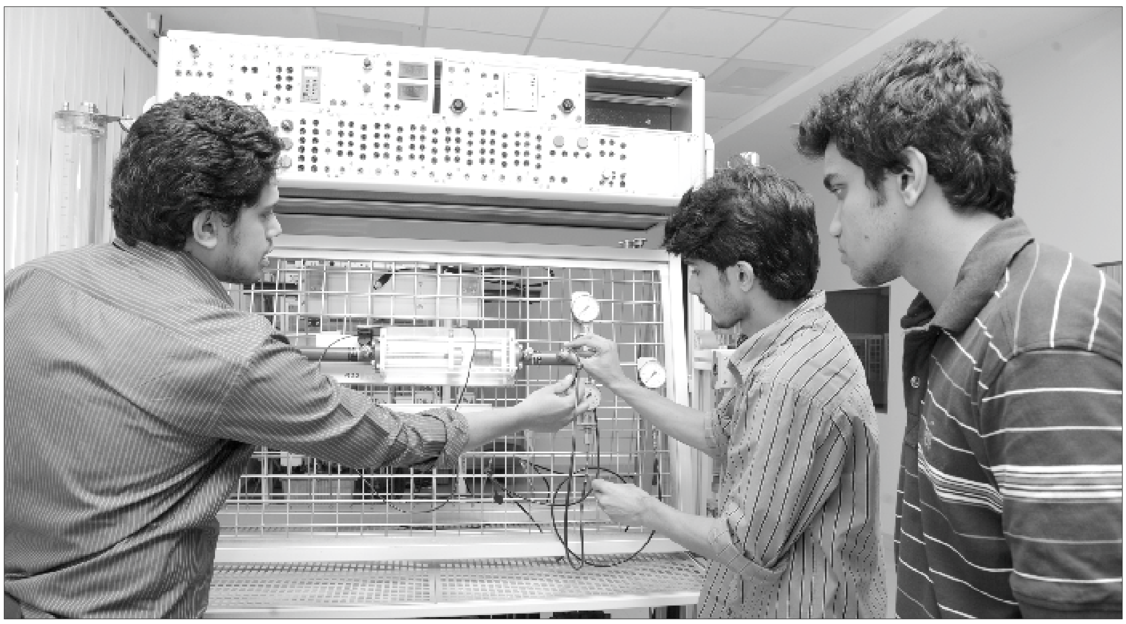
1. "Product Design and Development", by Karl T. Ulrich & Steven D. Eppinger, Mc Graw Hill, 2012.
2. "Reverse Engineering – Technology of Reinvention", by Wego Wang, CRC Press, 2011.
3. "Methods in Product Design – New strategies in Reengineering" by Ali K. Kamrani, Maryam Azimi, and Abdulrahman M. Al-Ahmari, CRC Press, 2013

MTE 5054 MACHINE LEARNING [3 0 0 3]

Introduction- Introduction to Machine Learning, Supervised Learning, Unsupervised Learning, Mathematical Preliminaries. Classification and Regression: Bayesian decision theory, Maximum likelihood ratio, Parametric classification, Regression, Multivariate methods, K-nearest neighbor classification. Supervised learning- Setup, LMS, Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naïve Bayes, Support vector machines, Model selection and feature selection, Evaluation and debugging learning algorithms. Unsupervised learning**-** Clustering, K-means, Hierarchical clustering, Competitive learning, Radial basis functions. EM, Mixture of Gaussians, Factor analysis, Principal Component Analysis, Independent Component Analysis. Application of unsupervised learning in anomaly detection and tactile manipulation. Deep Learning-Introduction to frameworks for deep learning, Convolutional neural networks-convolutional layer, pooling layer, normalization layer, fully-connected layer, conversion of fully-connected layer to convolutional layers. ConNet architecture-layer patterns, layer sizing patterns, case studies (LeNet/AlexNet/ZFNet/GoogLeNet). Generative adversarial network-Generator, Discriminator.

References:

1. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2. Ethem Alpaydin, "Introduction to Machine Learning", 2nd edition, MIT Press, 2010.
3. Mehryar Mohri, Afshin Rostamizadeh and Amet Talwalkar, "Foundation of Machine Learning", MIT Press 2012.
4. Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", MIT Press, 2009.
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.



Department of Printing and Media Engineering

Global communication sector has propelled us into the new millennium with engineering innovations and newer technologies. Electronic Publishing, Audio Visuals, Multimedia, Digital Data Transfer and Social Media are creating a new world of media market. The printing industry sees itself as media service and information processor. Born out of this niche is B.Tech in Media Technology at MIT, Manipal, an applied engineering course that deals with the comprehensive study of print and media technologies. Along with the B. Tech degree, students can also be entitled to a minor Specialization in Film Production, Packaging Technology or Business Management. Department offers M. Tech in Printing and Media Technology.

Since 1992, Department has built a strong edifice to become one of the leading Print and Media Institute of the country and has one of the best infrastructures available for Print and Media Technology. The key feature of the department is its Collaboration with Chemnitz University of Technology, Germany for joint research and development, joint projects, faculty exchange, student projects, and the availability of DAAD Scholarship for students exchange programme at Germany. Students have added advantage of getting hands on training & exposure on state of the art equipment in Manipal Technologies Limited, Manipal one of the leading Print and Media Organizations in Asia. Students after successful completion of Print and Media Technology course can get job in printing companies and media houses across countries. Generally, students are recruited by the major commercial printers, advertising agencies, newspapers/magazines, machine manufacturers, packaging industries, media houses. Students can also try placement at various government departments and banks. Student can also explore the possibility of entrepreneurship in Print and Media Sector.

Programs offered

Under Graduate Program

- B.Tech in Media Technology

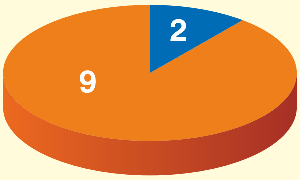
Post Graduate Program

- M.Tech in Printing and Media Technology (2008)

PhD

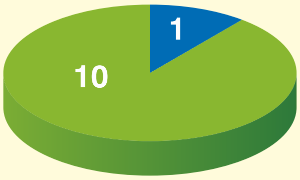
Faculty Strength

Qualification-wise

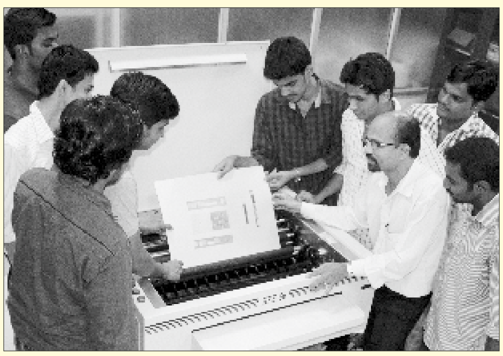


- PhD
- M.Tech/ME/M.Sc
- B.Tech/BE

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors



DEPARTMENT OF MEDIA TECHNOLOGY, MIT Manipal

M.Tech. PRINTING AND MEDIA TECHNOLOGY

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5153	Statistics, Probability and Reliability	4	0	0	4	PMT 5251	Advances in Packaging Technology	4	0	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	PMT 5252	Color Management Systems	4	0	0	4
	PMT 5151	Advances in Print Media	4	0	0	4	PMT ****	Elective I	4	0	0	4
	PMT 5152	Print Finishing and Converting	4	0	0	4	PMT ****	Elective II	4	0	0	4
	PMT 5153	Printing Material Technology	4	0	0	4	PMT ****	Elective III	4	0	0	4
	PMT 5154	Quality Control and Standardization in Printing	4	0	0	4	*** ****	Open Elective	3	0	0	3
	PMT 5161	Imaging and Printing Lab	1	0	2	2	PMT 5262	Packaging Technology Lab	0	0	3	1
	PMT 5162	Quality Control and Standardization in Printing Lab	0	0	3	1	PMT 5263	Color Management Systems Lab	0	0	3	1
		Total	**22**	**0**	**8**	**25**		**Total**	**23**	**0**	**6**	**25**
II	**THIRD AND FOURTH SEMESTER**											
	PMT 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CSE 5041	Advanced Techniques in Computer Graphics	PMT 5002	Electronic Publishing Technology
CSE 5042	Computer Data Processing	PMT 5003	Environment Management for Printing Industry
HUM 5041	Entrepreneurship Development	PMT 5004	Print Production and Business Management
HUM 5042	Print Logistics Management	PMT 5005	Standardization and Optimization of Offset Printing Process
PMT 5001	Advances in Specialty Printing		

OPEN ELECTIVES			
PMT 5051	Graphic and Publishing Design		

SEMESTER I

MAT 5153 STATISTICS, PROBABILITY AND RELIABILITY [4 0 0 4]

Basics of Statistics: Applications of Mean, Median, Mode, Standard deviation, Correlation coefficient in analyzing quality related data. Preliminary analysis of data by graphical representation, Measure of central tendency dispersion, peakedness in context with construction industry and quality control problems. Dependent Variables, Co-relation, Co-relation Coefficient and it's significance. Basic Probability: Random Variables and its properties. Probability of discrete and Continuous variables. Probability Mass Function, Probability Density Function, Cumulative Density Function. Discrete and Continuous Standard Probability Distributors and their properties. Central Limit theorem, Equivalent Normal distribution for Non-Normal distributions. Utilization of random events, measures of probability concepts for quality control related issues. Applications of Frequency distribution and probability, probability distributors, continuous and discrete distributions in analyzing data related to process and quality control. Goodness of fit tests: Chi-square test, Kolmogorov-Smirnov Goodness of fit test and two sample test. Monte-Carlo Simulation. Reliability Analysis: Concept of Reliability, Risk and Safety factors. Safety Margin function, Reliability Index. FOSM method of Reliability Analysis. Application of FOSM to Linear and Non Linear Safety Margin Functions-Hasofer-Lynd method.

References:

1. Wackerly D. D., Mendenhall W., and Scheaffer R. L. “Mathematical Statistics with applications”,7th Edition, Thomson(Brooks/Cole)., 2008.
2. Angand Tang, “Probability concepts in engineering planning and design”, Vol. I and II, Wiley International, 1984.
3. Kottegoda N.T., Rosso Renzo, “Statistics, Probability and Reliability for Civil and Environmental Engineers”, Mc-Graw Hill International, 1998.
4. Ramachandran K.M., Tsokos C.P., “Mathematical Statistics with applications”, Academic Press, 2009.
5. Ramachandran K.M., Tsokos C.P., “Mathematical Statistics with applications, Student Solution Manual”, Academic Press, 2009.

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL COMMUNICATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

References:

1. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
2. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
3. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
4. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

PMT 5151 ADVANCES IN PRINT MEDIA [4 0 0 4]

Introduction Print Media industry. Offset printing: Principle and image carriers. Sheet-fed and web-fed press components and operations, control systems, production, quality control and automation. Control console and measurement systems, inline print quality control and measurement. Flexograhy: Principle and image carriers. Unwind and rewind facility, tension control systems, printing unit and anilox roll. Gravure: Principle and image carriers. Printing unit, gravure cylinder and engraving, impression system and ESA ink transfer, Gravure dryers, trouble shooting. Screen printing: Principle and image carriers. Mesh and mesh parameter control, stenciling systems, laser imaging of rotary screens, Surface mount technology, Screen printing machines for printing sheet and web, Textile screen printing and specialty printing**.** Digital printing: Non-Impact Printing Technologies, Electrophotography, Inkjet printing technologies, Quality control in digital printing, Hybrid printing.

References:

1. Samuel B.H., “Screen Printing - Contemporary Approach” Delmar publisher, New York, 1997.
2. Kipphan Helmut, “Handbook of Print Media” Springer, Germany, 2001.
3. Lloyd P Dejidas and Thomas M Destree, “Sheetfed Offset Press Operating”, GATF, USA, 2005.
4. Daniel G Wilson and PIA/GATF Staff, “Web Offset Press Operating”, GATF, USA, 2005.
5. David J Lanska, “Common-sense Flexography: A user's guide to improved press productivity”, GATF, US, 2007.

PMT 5152 PRINT FINISHING AND CONVERTING [4 0 0 4]

Print finishing development and trends. Planning of materials used for book binding. Standard paper sizes. Latest trends in folding, cutting, coating, laminating, stitching, foiling, stitching and sewing. Developments and trends in Adhesive book binding and its consumables. Trends in Mechanical book binding. Development and growth of Digital book binding. Process structuring and quality control in binding.

References:

1. Speirs Hugh M, “Print Estimators The Hand Book” BPIF, London, 1996.
2. Speirs Hugh, “Introduction to printing and finishing” PIRA, UK, 1998.
3. Mendiratta B D, “Printers Costing and Estimating”, Printtrade Publications, New Delhi, 1999.
4. Lyman Ralph, “Binding and finishing” GATF, USA, 2000.
5. Tedesco T J, “Binding, finishing and mailing: the final word”, GATF Press, Pittsburgh, 2005.

PMT 5153 PRINTING MATERIAL TECHNOLOGY [4 0 0 4]

Various materials used in printing; Light sensitive materials, Light sensitive coatings in lithoplates- positive and negative plate coatings - characteristics, exposure & processing, photopolymer coatings in flexoplates- solid & liquid photopolymer plates, photo sensitive coating in waterless lithoplates; Materials used for various image carriers - Metals, alloys, Polymeric materials, Elastomers, Screen & stencil material for screen printing, Electrostatic image carriers, Organic photoconductors; Printing inks and toners- UV curable inks, Water based and Plastisol inks, Metallic inks, Conductive inks, Magnetic inks, Fluorescent inks, Nitrocellulose based inks, Specialty inks used for security printing, toners; Overprint varnishes - Types, formulation, characteristics & applications. Coatings - Carboset GA-33 in water based inks for Vinyl substrates, Carboset GA-33 top coat for Vinyl floor coverings, Vinyl Plastisol coating; Printing Substrates- types and properties of paper, Board - types, characteristic properties, storage & handling, Other substrates- Plastic films, metal foils, glass, textile, substrate for digital printing and specialty printing; Rollers & Blankets - structure, types, characteristics & applications, selection ,storage & handling, blanket washes, under blankets; Chemicals, solvents and solutions used in printing.

References:

1. Eldred Nelson R and Scarlett Terry, "what the printer should know about ink" GATF, US, 1990.
2. Bob Thompson, "Printing materials science and technology", PIRA International, U.K, 1998.
3. Flick, E.W, "Printing Inks and Overprint Varnish formulations", Second Edition, William Andrew Publishing, 1999.
4. Biermann Christopher, "Handbook of pulping and papermaking", Academic Press, California, 2005.
5. Prakash Shetty, "Science and Technology of Printing Materials", MJP Publlshers, Chennai, India, 2008.

PMT 5154 QUALITY CONTROL AND STANDARDIZATION IN PRINTING [4 0 0 4]

Quality, quality control, quality assurance, TQM and its components. Optical, physical and mechanical properties of printing substrates, standards, measuring techniques and evaluating procedures. Composition and requirements and testing of offset inks Quality Standardization in printing industry, substrate, ink and press properties, Perception of color, Influence of print attributes. CtP systems, Linearization and Calibration process, Evaluation of plate quality, RIP, PDF, JDF, CIP3/CIP4 workflow Quality control in dampening system, test forms, methods, devices, roller setting, troubleshooting, Test targets for evaluating print quality. Gracol, G7methods, P2P25X charts, NPDC curves, TVI curves, SNAP, ISO and IFRA- WAN standards.

References:

1. Richardson K Kristin, "Total Quality Management in the Printing and Publishing Industry", Graphic Communications Association, USA, 1992.
2. Bureau H William, "What the Printer should know about Paper" GATF, USA, 1997
3. Gregory A Bassinger, "GATF Test Form / Analysis User Guide", Graphic Arts Technical Foundation, Pittsburgh, 1997.
4. Dalphod Julie,, "A critical review of the variables in offset printing: effects on print", Pulp and Paper Technical Association of Canada, Canada, 1999.
5. Nelson R.E. and Terry Scarlett, "What the printer should know about ink" GATF, USA, 2001.

PMT 5161 IMAGING AND PRINTING LAB [1 0 2 2]

Planning and Layout for bookwork, Surface plates for offset printing, Inking, Dampening, printing unit settings on offset machine, print quality and troubleshooting, polymer plates for flexography, flexo plate mounting. Print and web parameter setting on press, stenciling systems for screen printing, mesh, squeegee, press parameter control.

List of Experiments:

1. Digital impositions for book work and folders
2. Page layout and imposition using RIP software
3. Study of exposure and development (conventional and auto-processing) factors on quality of the plate
4. Setting sheet control devices, inking, dampening, Plate and blanket mounting
5. Single color printing using offset press and print quality evaluation
6. Multi-color printing using offset press and Print quality evaluation
7. Photopolymer plate making for flexographic process.
8. Plate mounting, Web feeding, tensioning and settings for single and both side printing and relative gear profile.
9. Screen stretching techniques, stencil preparation and single color screen printing.
10. Stencil preparation and multicolor screen printing
11. Stencil preparation and multicolor (overlapping colors) screen printing
12. Study on OFF-contact Vs ON- contact screen printing

References:

1. Samuel B.H., "Screen Printing - Contemporary Approach" Delmar publisher, New York, 1997.
2. Kipphan Helmut, "Handbook of Print Media" Springer, Germany, 2001.
3. Lloyd P Dejidas and Thomas M Destree, "Sheetfed Offset Press Operating", GATF, USA, 2005.
4. Daniel G Wilson and PIA/GATF Staff, "Web Offset Press Operating", GATF, USA, 2005.
5. David J Lanska, "Common-sense Flexography: A user's guide to improved press productivity", GATF, US, 2007.

PMT 5162 QUALITY CONTROL AND STANDARDIZATION IN PRINTING LAB [0 0 3 1]

List of Experiments:

1. Study of optical properties of paper and boards – Brightness, Opacity, Gloss, L a b, and whiteness
2. Study of physical properties of paper and boards – Cobb sizing, GSM & Bulk
3. Study of physical properties of paper and boards –Porosity & Moisture content
4. Study of mechanical properties of paper and boards- Tensile and Tearing strength
5. Study of mechanical properties of paper and boards- Ply bond strength & Folding endurance
6. Study of mechanical properties of paper and boards- Stiffness and bursting strength
7. Printability test of different paper substrates using IGT –C1 offset Printability tester.
8. Study of optimal Solid ink density (SID) chart
9. Study of viscosity of printing inks
10. Offset ink emulsification test
11. Linearization of digital proofer
12. Working on G7 fan graph and Curve 3 software
13. Standardization of conventional plate making process parameters using Ugra conventional plate control wedge.

References:

1. Nelson R.E. and Terry Scarlett, "What the printer should know about ink" GATF, USA, 1990.
2. Ronald E.T., "Printing inks formulation principles, manufacture and quality control testing procedures" PIRA International, UK, 1994.
3. Finley Charles, "Printing Paper and Inks" Delmar Publishers, New York, 1997.
4. Bureau H William, "What the Printer should know about Paper" GATF, USA, 1998.
5. Universal Engineering Corporation "Operating Manual for Quality Testing devices"

SEMESTER II

PMT 5251 ADVANCES IN PACKAGING TECHNOLOGY [4 0 0 4]

Compatibility of the package with the product, Product Life Cycle, Systems approach to packaging. Advances in die making techniques, gas packaging systems, molding and extruder system Types, characteristics, functions of various packaging materials. Packaging design: Surface and Structural Design of packaging using various materials. Recent trends in packaging technologies for food, pharmaceutical products, cosmetic products and fruit juice. Package Testing: Evaluation of transport worthiness of packages - Physical and environmental, Mechanical and climatic Tests. Recent Advances in Packaging: Future trends, environmental implication of packaging

References:

1. A.I. Brody and K. S. Marsh, "Encyclopedia of Packaging Technology", Second edition, John Wiley & Sons, New York, USA, 2000.
2. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Handbook of Package Engineering", Fourth Edition, CRC press, 2007.
3. Otto G. Piringer, A. L. Baner, "Plastic Packaging: Interactions with Food and Pharmaceuticals", 2nd edition, Wiley-VCH, Germany, 2008.
4. Engineers India Research Institute, "Handbook of Packaging Technology", EIRI board, New Delhi, 2008.
5. Joseph Kerry, Paul Butler, "Smart Packaging Technologies for Fast Moving Consumer Goods", Wiley-Blackwell, First edition, USA, 2008.
6. Emblem and H. Emblem, "Packaging Technology - Fundamentals, materials and processes, Woodhead publishing Limited", Cambridge, UK, 2012.

PMT 5252 COLOR MANAGEMENT SYSTEMS [4 0 0 4]

Fundamentals of Color: Light theory, Object, Observer, Psychological aspects, Color deficiencies, Color vocabulary, Color Classification Systems, Conversions between the coordinates, Color Measurement, Luminance & illuminance, Spectral Power Distribution, Color Temperature, Standard Observers & Standard Illuminant, Densitometers, Colorimeters & Spectrophotometers, Color Appearance and Color Rendering properties, Color Management - Profiles, PCS, CMM, Rendering Intents, Workflow of conversions, ICC color workflow, ICC Recommendations for Color Measurement, ICC Version 2 and Version 4 Profiles, Profile Construction and Profile Anatomy.

References:

1. Heinrich Zollinger, "Color: A Multidisciplinary Approach", VHCA & Wiley VCH, Germany, 1999.
2. Noboru Ohta & Alan R. Robertson, "Colorimetry - Fundamentals and Applications", JohnWiley & Sons Ltd, U.K. 2005.
3. Bruce Fraser, Chris Murphy and Fred Bunting, "Real World Color Management", Peachpit Press, Berkeley, CA, 2005.
4. Edward J.G. and Thomas E.M., "Digital Color Management", John Wiley & Sons Ltd, UK, 2008.
5. Jan-Peter Homann, "Digital Color Management", Springer-Verlag Berlin, 2009.
6. Phil Green, "Color Management - Understanding and Using ICC Profiles", JohnWiley & Sons Ltd, U.K, 2010.

PMT 5262 PACKAGING TECHNOLOGY LAB [0 0 3 1]

List of Experiments:

1. Familiarizing tools in ESKO ArtiosCAD and ESKO Deskpack softwares .
2. Designing carton box using ESKO ArtiosCAD.
3. Working with 3D options in ESKO ArtiosCAD.
4. Working with ESKO Studio software.
5. Working on Die cutting machine to prepare carton.
6. Analyzing Compression Strength of various cartons.
7. Analyzing abrasion resistance of various packaging board materials.
8. Estimating the box compression strength by measuring ECT and RCT of packaging boards.
9. Analyzing Delaminating Strength of various packaging boards.
10. Determining the Co-efficient of friction of various flexible packaging materials.
11. Evaluating the vibration strength of packaging box.
12. Analyzing the effect of coating on the abrasion resistance of packaging boards.

References:

1. Briston John, "Advances in Plastic Packaging Technology" PIRA, UK, 1992.
2. Gordon Robertson L., "Food Packaging principles and Practice" Marcel Dekker Inc., 1993.
3. Chakravarty B, "A Hand Book for Printing and Packaging Technology" Galgotia Publications, 1997.
4. Natarajan S, Fundamentals of packaging technology, PHI, New Delhi, 2009

PMT 5263 COLOR MANAGEMENT SYSTEMS LAB [0 0 3 1]

List of Experiments:

1. FM HUE TEST
2. Measuring Illumination using Xrite i1
3. Calibration & Characterization of LCD monitor using ColorMunki
4. Characterization of CRT and LCD monitor using Monaco optics
5. Characterization of CRT and LCD monitor using Xrite i1
6. Characterization of Projector using ColorMunki and Xrite i1
7. Characterization of Scanner using PULSE ColorElite software
8. Characterization of Digital Camera using PULSE ColorElite software
9. Characterization of Printer using ColorMunki and Xrite i1i0
10. Dot gain from LAB values and Print Characteristics from D19C and D530
11. Dot gain on Plate and Printed sample using IC Plate II and Plate Scope
12. Measuring Hue error, Contrast & Grayness using D19C and D530

References:

1. Lindsay W. MacDonald and M. Ronnier Luo, "Color Image Science", John Wiley & Sons Ltd, England, 2002
2. Gaurav Sharma, "Digital Color Imaging Handbook", CRC Press, USA, 2003.
3. Maureen C. Stone, "A Field Guide to Digital Color", A K Perters Ltd, USA, 2003.

4. Abhay Sharma, “Understanding Color Management”, Thomson Delmar Learning, USA, 2004.
5. Bruce Fraser, Chris Murphy and Fred Bunting, “Real World Color Management”, Peachpit Press, USA, 2005.

SEMESTER III & IV

PMT 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CSE 5041 ADVANCED TECHNIQUES IN COMPUTER GRAPHICS [4 0 0 4]

Computer Graphics and Multimedia: Computer Graphics, Overview of Graphics System, Digital Print, Comparing Digital Printing Technologies, Creating and Processing the Image, File Formats, Image Compression, and More, Color Models and Applications, Supporting software for computer Graphics. Web Design: Web Typography, Graphics and color, HTML Frames, Publishing and maintain your Web Site, Web servers, Web browsers, Web Page makers and site builders. XML Animation: Computer Animation, Principles of Animation, 2D Animation overview, 2D Animation Basics, Finessing 2D Animation, 2D Vector Animation, 3D Overview, Creating 3D movement, The work flow process, Conceptualizing the animation, The Mechanics of Three Leading Programs (LightWave, 3DS Max, MAYA). Using LightWave to create object rendering Flash: animation and interactivity, Basic concepts, Drawing, Importing Artwork and manipulating, Animation, Sound, Actions. To create animation with action script.

References:

1. Peter Jerram and Michael Gosney, “Multimedia Power Tools” Second Edition, Random House Electronic Publishing, 1995.
2. Harald Johnson, “Mastering Digital Printing” Second Edition, Thomson Course Technology*, 2004.
3. Roy Disney, “Animation from Pencils to Pixels” Elsevier Focal Press*, 2006.
4. Joel Sklar, “Principles of Web Design” Thomson India Edition, 2007.
5. Donald Hearn, M. Pauline Baker, “Computer Graphics using OpenGL”, Third edition*, 2012.

CSE 5042 COMPUTER DATA PROCESSING [4 0 0 4]

Database-System Applications, Relational Databases, Database Design, Transaction Management, Database Architecture. Introduction to Relational Model, Data Definition, SQL Data Types, Basic SQL Operations, Set Operations, Aggregate Functions, Null Values, Nested Queries, Joined Expressions, Integrity Constraints, Overview of the Design Process, The Entity-Relationship Model, Constraints, E-R Diagrams, Design Issues, Extended E-R Features, Relational Database Design, Atomic Domains and First Normal Form, Functional Dependency Theory, Physical Storage Media, File Organization, Static and DynamicHashing, Transaction Management- Transaction Atomicity and Durability, Serializability, Isolation, Application Programs and User Interfaces, Web Fundamentals, Application Architectures, Application Performance.

References:

1. Ramakrishnan and Gehrke, “Database Management Systems”, 3rd Edition, McGraw Hill, 2000.
2. Silberschatz, Korth, Sudarshan, “Database System Concepts”, 6th Edition, McGrawHill, 2011.
3. Ramez Elmasri, Shamkant B Navathe, “Database Systems”, 6th Edition, Pearson Education, 2013.

HUM 5041 ENTREPRENEURSHIP DEVELOPMENT [4 0 0 4]

Recognition of the need for entrepreneurship and self-employment development. Scope and trends of small enterprises. International experience. local economic development. Small business / enterprise - driving force for national growth, Self-assessment. Franchises. Creating your own franchise. Turnkey or packaged business. Multi-level marketing schemes. Business plan - the major benefits. Sub-plans.Business plan - blueprint to success and financing. Sample Evaluation instrument. Government rules and regulations. Elements of contract law. Selling your venture. Selling your venture/planning for succession. Valuation of a business. Work management. How to make sure that work gets done. Ethics and Responsibility of an Entrepreneur. Different models of training. Entrepreneurship Development Centre's: NSIC, TECSOK, SIDBI, KIADB, KSFC.

References:

1. Saini Jasmer Singh, “Hand book of Entrepreneurship Development” Deep and Deep Publications, Delhi, 1997.
2. CPSC, “Entrepreneurship Development” McGraw Hill, Delhi, 1998.
3. Basotia G R and Sharma K K, “Hand book of entrepreneurship development”, Mangal Deep Publishers, Jaipur, 1999.
4. Charantimath Poornima M, “Entrepreneurship development and small business enterprises”, Pearson, New Delhi, 2006.
5. Yadav C P, “Encyclopedia of entrepreneurship development”, Anmol publications Pvt. Ltd, New Delhi, 2006.

HUM 5042 PRINT LOGISTICS MANAGEMENT [4 0 0 4]

Understanding the Supply Chain: Importance, Decision Phases and Process View. Supply Chain Performance - Achieving Strategic Fit and Scope. Achieving Strategic Fit. Supply Chain Drivers and Metrics: Drivers, Performance, Framework, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Obstacles. Designing Distribution Networks and Applications to e-Business: The Role and Factors, Design Options, e-Business and the Distribution Network, Distribution Networks in Practice. Network Design in the Supply Chain: The Role and Factors, Framework, Models for Facility Location and Capacity Allocation. Planning Supply and Demand in a Supply Chain: Managing Predictable Variability - Responding to Predictable Variability, Managing Supply and Demand, Implementing Solutions to Predictable Variability in Practice. Transportation in a Supply Chain: The Role and Modes of Transportation and Their Performance Characteristics, Infrastructure and Policies, Design Options, Trade-Offs, Tailored Transportation, Risk Management. Coordination in a Supply Chain: Lack of Coordination and the Bullwhip Effect, Obstacles, Building Strategic Partnerships and Trust, Collaborative Planning, Forecasting, and Replenishment (CPFR). The Role of IT in all aspects of supply chain.

References:
1. Handfield, R. B., & Nichols, E. L, “Introduction to supply chain management” Vol. 183, Upper Saddle River, Prentice Hall, NJ, 1999.
2. Simchi-Levi, D., “Designing and managing the supply chain” McGraw Hill College, 2005.
3. Chopra, S., & Meindl, P., “Supply chain management. Strategy”, planning & operation, pp. 265-275, Gabler, 2007.
4. Monczka, R., Handfield, R., Giunipero, L., & Patterson, J., “Purchasing and supply chain management” Cengage Learning, 2008.

PMT 5001 ADVANCES IN SPECIALTY PRINTING [4 0 0 4]

Printed Electronics, integrated smart systems, Printed intelligence, Fabrication Process, Substrates, Inks, OLED, OTFT, solar cells, battery, sensors, RFID, quality testing. Security printing: Inks, Security features, Finishing processes. Lenticular and 3D printing: Types and effects, printing process, Creating 3D effect. Variable data printing, Hologram and holography, Continuous stationery, Envelope making, Carbonless and Thermal paper, Converting processes.

References:
1. Helmut Kipphan, “Handbook of Print Media”, Springer, Germany,2001
2. Richard D Warner and Richard M Adams, “Introduction to security printing” GATF press, USA, 2005.
3. Stijn De Vusser et.al., “Integrated shadow mask method for patterning small molecule organic semiconductors”, Applied Physics Letters, American Institute of Physics, 2006.
4. Shlomo Magdassi et.al., “Copper Nanoparticles for Printed Electronics: Routes Towards Achieving Oxidation Stability”, Materials, 2010.
5. Katsuaki Suganuma, “Introduction to Printed Electronics”, Springer, New York, 2014.

PMT 5002 ELECTRONIC PUBLISHING TECHNOLOGY [4 0 0 4]

Evolution, products & services. Document Management Systems: components, challenges, digital library. Digital Rights Management: fair use, challenges, transactions, Intellectual Property Rights, storage & distribution, functional architecture. E-publishing: Role of – author, publisher, e-tailer, user, self-publishing, Copyright - Issues, contracts, copyright law, cyber law. Digital Asset Management: Content management, DAM – components, types, system functionality. E-commerce: Electronic Data Interchange, e-business, models, transaction processing cycle, mobile commerce. Authentication Mechanisms. Information Retrieval. Broadcasting, NewsML, AdML, EXIF, web ads and advertising, wireless communications, LaTEX, SGML, XML and HTML.

References:
1. Michael B. Spring, “Electronic Printing and Publishing” Marcel Dekker, Inc. New York, 1991.
2. Borgman, C.L., “From Gutenberg to the Global Information Infrastructure: Access to Information in the Networked World”. Cambridge: MIT Press, 2003.
3. Hey, T. & Trefethen, A, “Cyberinfrastructure and e-Science. Science”, 308: 818-821. Retrieved from http://www.sciencemag.org/cgi/content/full/308/5723/817, 2005.
4. Claudette, “Reporting and Production for Digital Media” Surjeet Publication, New Delhi, 2005.
5. Borgman, C.L., Scholarship in the Digital Age: Information, Infrastructure and the Internet. Cambridge: MIT Press. (Available at LuValle Commons Bookstore), 2007.

PMT 5003 ENVIRONMENT MANAGEMENT FOR PRINTING INDUSTRY [4 0 0 4]

Environmental pollution, Major waste streams, Sources and Principal releases to the environment by different printing processes, Waste reduction, Pollution Prevention (P2), Cleaner Production, drivers and barriers of P2, P2 program, P2 strategies - pre-press, press, post-press, Environmental Management Systems, ISO 14000, Environmental accounting, Systematic process optimization, Environmental regulations, Environmental health and safety, Environmental sustainability, Eco-friendly printing.

References:
1. Jones Gary A, “Air Pollution Engineering Guide For Graphic arts Industry”, GATF, USA, 1993.
2. F.F.T.A., “Flexography: Principles and Practices”, Fifth Edition, Foundation of Flexographic Technical Association Inc., USA, 1999.
3. Kipphan Helmut, “Handbook of Print Media”, Springer, Germany, 2001.
4. Melissa Malkin Weber and Mark Bahner, “Manual on Pollution Prevention for the Printing Industry”, Research triangle Institute, North Carolina.

PMT 5004 PRINT PRODUCTION AND BUSINESS MANAGEMENT [4 0 0 4]

Printing process industry and operations, Productivity calculation in printing industry, Capacity planning and measuring, Theory of constraints, Factors affecting location decisions, Layout planning and types, Demand characteristic, Pattern of Demand, Factors affecting demand, Designing the forecasting system, Inventory concept, Inventory reduction tactics, Calculating EOQ and its effect, Material requirement planning and its benefits, Link between Corporate Strategy and Functional area Strategies in printing Industry, Scheduling, Decision making tools and techniques.

References:
1. Adam E., “Operation Management”, Prentice Publication, Delhi, 1993.
2. Chary S. N., “Operations Management”, Tata McGraw Hill, New Delhi, 2000.
3. Paneerselvam R., “Operations Management”, Prentice Hall, Delhi, 2001.
4. Jhamb L. C., “Text book on Operation Management”, Everest Publication, Pune, 2002.
5. Krajewski L. J, “Operations Management”, Pearson Education, 9th edition, Delhi, 2010

PMT 5005 STANDARDIZATION AND OPTIMIZATION OF OFFSET PRINTING PROCESS [4 0 0 4]

Evolvement of technological development - Present Status of Indian Print Industry. Environment Management Systems. Carbon Foot Print, Energy Conservation and Logging, Sinusoidal synchronous main drive technology. Standardisation of paper, ink and consumables – their Environmental impact. Anti- setoff Spray, VOC Emissions from Wash-up Solvents and cleaners. Optimising offset printing - Purpose, Process Integration. Prepress Standardisation - Plate, Computer - to - plate (CtP), processor and Quality control. Standardizing the printing machine -

Paper feeder, plate and blanket cylinders, dampening, Inking and Delivery, Registration. PAN4C analysis print test form, Eco Friendly Printing and Digital Workflow. Print Evaluation before and after optimising the press. Sustainability management - Eco Friendly Printing Initiatives, ROI, Reducing energy consumption, emissions, waste and CO2. Print Related Standards, Environmental Regulations and Legal Framework. Environment Protection acts, ISO standards, Altona Test Suite 2004/2005, UGRA/FOGRA, Print Media Standard, 2004. Manifestations of problems and remedy during offset printing - press and print related problems

References

1. Kipphan Helmut, "Handbook of Print Media" Springer, Germany, 2001.
2. Hattori, H., Watanabe, K., "Eco-Friendly Fountain Solution for Offset Printing" Graphic Materials Research Laboratories Research & Development Management Headquarters FUJIFILM Corporation, UDC 655.226.28+504.06., 2008.
3. Board, E., "Hand Book of Pulp & Paper, Paper Board And Paper Based Technology"., 2009.
4. Ludwig, H, F., Evans, J., Brockelman, W, Y., Lohani, B, N., "Manual of Environmental Technology in Developing Countries", South Asian Publishing P. Ltd, New Delhi, 2009.
5. Peter N., Sole A., Hardeberg, J. Y., "Analysis of color measurement uncertainty in a color managed printing workflow", Journal of Print and Media Technology research. Norway, 2012.

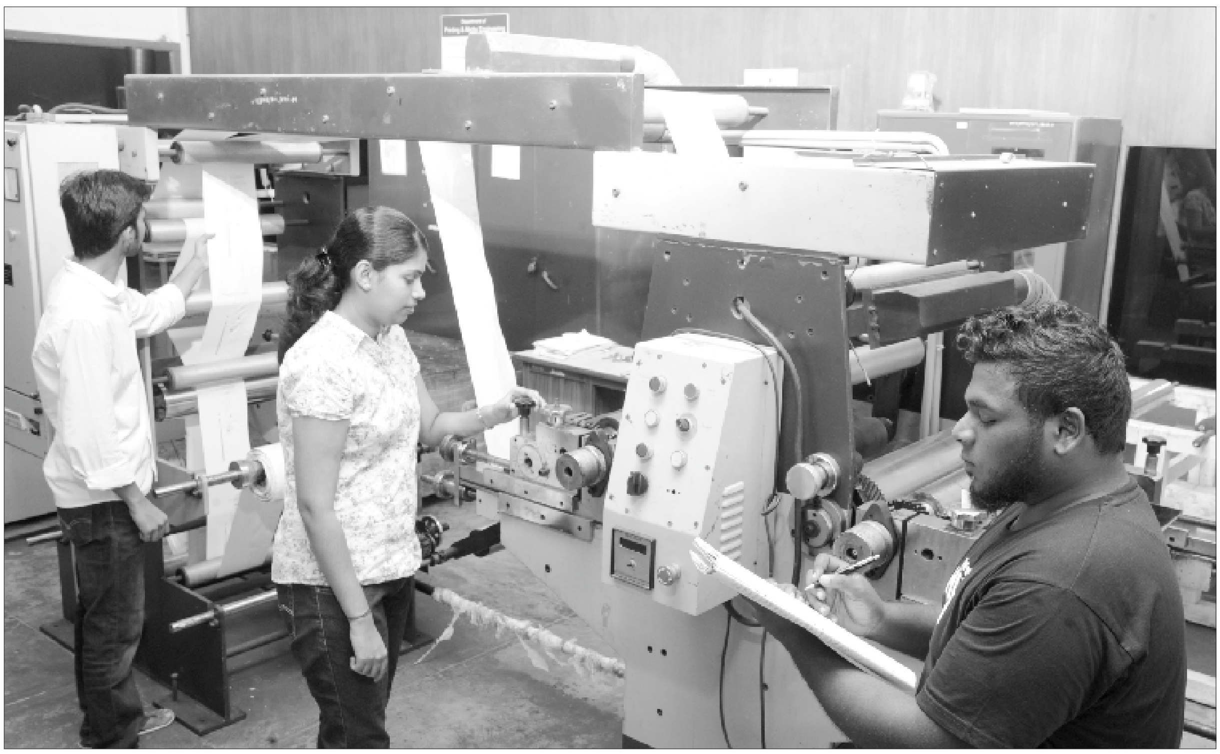
OPEN ELECTIVES

PMT 5051 GRAPHIC AND PUBLISHING DESIGN [3 0 0 3]

Graphic Design, Purpose and Influences, Elements of basic design, Principles of graphic design, Role of the designer, Process of Design, Design approach and execution, Graphic design process, Components of design problems, Creative thinking, Visualization, Composition, Layouts and grids, Softwares of graphic design and publishing design - Photoshop, Illustrator, InDesign -acquaintance and navigating, Publication Design - Newsletter, Magazine Ads, Boucher, Posters, Pamphlet, Flyer, Report, Forms, Information Packets, Booklets, Manuals, Advertising Design.

References:

1. Bryan Lawson, "How Designers Think - The Design Process Demystified", Elsevier, Burlington, 2005.
2. Amy E. Arntson, "Graphic Design Basics", Thomson Wadsworth, 2007.
3. Gavin Ambrose and Paul Harris, "The Production Manual - A Graphic Design Handbook", AVA Publishing SA, Switzerland, 2008.
4. Gavin Ambrose and Paul Harris, "The Fundamentals of Graphic Design", AVA Publishing SA, Switzerland, 2009.
5. Robin Landa, "Graphic Design Solutions", Wadsworth, USA, 2011.



Department of Computer Applications

The department of Computer Applications was started in 1998 as a part of the department of Mathematics, affiliated to Mangalore University. Subsequently, it was a part of the Information and Communication Technology engineering department, Manipal University. Since 2009, this department has been functioning as an independent department at MIT offering the 2-year Master of Computer Applications program, located strategically in the Innovation Center of MIT. Over the years, the department has evolved into a centre for excellence providing opportunities for innovation and research with well-equipped computer facilities and dedicated faculty, who apart from their regular teaching schedule, are actively involved in pursuing research in various areas like Data Analytics, Video Coding, Network Security, Knowledge Engineering and Cloud Computing. The department has a good record of research activities with many publications in conferences and journals. The department has three research groups namely Data and Knowledge Discovery, Multimedia Computing and Communication and Computer Vision. The groups are active and are conducting various activities such as workshops, seminars etc. Students of the department have successfully carried out final semester internship with the Cerner Healthcare, Sapient, Deloitte, Accenture, HackerEarth, MDS, MDN, TCS, Accolade, Robosoft apart from in-semester summer internship projects The department has an international exchange program as part of IAESTE and AIESEC for MCA students. To ensure their holistic development of students, department has various activities such as the Open Source Technology Forum Club with technical sessions including hands on experiences conducted by students/faculty and the flagship Annual National Level Technical department fest: Techno Melange.

Programs offered

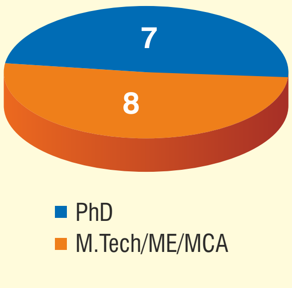
Under Graduate Program
- B.Tech in Data Science and Engineering

Post Graduate Program
- Master of Computer Applications (1998)

PhD

Faculty Strength

Qualification-wise



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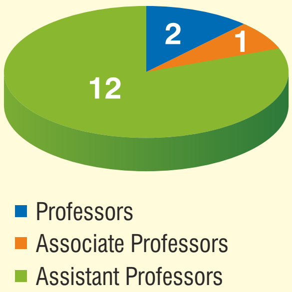

DEPARTMENT OF COMPUTER APPLICATIONS, MIT Manipal

MCA (MASTER OF COMPUTER APPLICATIONS)

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 4151	Computational Mathematics	4	0	0	4	MCA 4251	Data Analytics	4	0	0	4
	MCA 4151	Database Management System	4	0	0	4	MCA 4252	Data Structures and Algorithms	4	0	0	4
	MCA 4152	Object Oriented Programming	4	0	0	4	MCA 4253	Java Programming	4	0	0	4
	MCA 4153	Operating Systems	3	0	0	3	MCA 4254	Web Technologies	4	0	0	4
	MCA 4154	Software Engineering	3	0	0	3	MCA ****	Elective I	3	0	0	3
	MCA 4161	Database Management System Lab	0	0	3	1	MCA 4261	Data Structures and Algorithms Lab	0	0	3	1
	MCA 4162	Linux Programming Lab	0	1	3	2	MCA 4262	Java Programming Lab	0	0	3	1
	MCA 4163	Object Oriented Programming Lab	0	0	3	1	MCA 4263	Web Technologies Lab	0	0	3	1
		Total	**18**	**1**	**9**	**22**		**Total**	**19**	**0**	**9**	**22**

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MCA 5151	Computer Networks	4	0	0	4	MCA 5298	Project Work	0	0	0	12
	MCA 5152	Machine Learning	4	0	0	4						
	MCA ****	Elective II	3	0	0	3						
	MCA ****	Elective III	3	0	0	3						
	MCA 5161	Machine Learning Lab	0	0	3	1						
	MCA 5162	Mobile Application Development Lab	0	1	3	2						
	MCA 5163	Network Lab	0	1	3	2						
	MCA 5164	Seminar	0	0	6	2						
		Total	**14**	**2**	**15**	**21**		**Total**	**0**	**0**	**0**	**12**

PROGRAM ELECTIVES					
HUM 5043	Human Resource Management	MCA 5032	Ethical Hacking	MCA 5039	Object Oriented Analysis and Design
MCA 5026	Big Data Analytics	MCA 5033	Game Programming	MCA 5040	Optimization Techniques
MCA 5027	Cloud Computing	MCA 5034	Information and Network Security	MCA 5041	Pattern Recognition Techniques and Applications
MCA 5028	Computational Intelligence	MCA 5035	Information Storage and Management	MCA 5042	Semantic Web
MCA 5029	Computer Organization and Architecture	MCA 5036	Internet of Things	MCA 5043	Service Oriented Architecture
MCA 5030	Cyber Forensics	MCA 5037	Management Information Systems	MCA 5044	Software Project Management
MCA 5031	Design and Analysis of Algorithms	MCA 5038	NoSQL Database Systems		

SEMESTER I

MAT 4151 COMPUTATIONAL MATHEMATICS [4 0 0 4]

Mathematical Logic: Statement (Proposition), Logical Connectives, Conditional, Bi-conditional, Converse, Inverse, Contra positive, Exclusive OR, NAND, NOR, Tautology, Contradiction, Satisfiable, Duality Law, Algebra of propositions, Mathematical Induction; Set Theory: sets, types of sets, cardinality of a set, subset and superset, comparability of sets, power set, operations on sets, disjoint sets, application of set theory, Graphs: Graphs, Computer Representations of Graphs, Isomorphic Graphs, Paths, Cycles and Circuits, Eulerian and Hamiltonian Graphs, Planar Graphs, Graph Coloring, Digraphs, Dags, Weighted Diagraphs; Trees: Trees, Spanning trees, Minimal Spanning Trees, Rooted Trees, Binary Trees, Binary Search Trees, Combinatorics and Discrete Probability: The Fundamental Counting Principles, Permutations, Combinations, Permutations and Combinations with Repetitions.

References:

1. Thomas Koshy, Discrete Mathematics with Applications, Academic Press, Reprint 2005.
2. D.P. Acharjya, Sreekumar, Fundamental Approach to Discrete Mathematics, New Age International (P) Limited, 2005.
3. Kenneth H Rosen, Discrete Mathematics & its Applications with Combinatorics and Graph Theory, 6th Edition, McGraw Hill, 2007.
4. Martin Aigne, Discrete Mathematics, American Mathematical Society, USA, 2007.

MCA 4151 DATABASE MANAGEMENT SYSTEM [4 0 0 4]

Database System Applications, Advantages, View of data, Database languages, Architecture, users and Administrator, SQL, Data Definition, Basic structure of SQL queries, Basic operations, Set operations, Null values, Aggregate Functions, Nested subqueries, Modification of the database, Intermediate SQL, Join, Views, Transactions, Integrity Constraints, Data types and schemas, Authorization, Advanced SQL, PL/SQL, Cursors, Functions, Procedures, Triggers, Entity-Relationship Model, Basic Concepts, Constraints, Design of ER database schema, Reduction of ER to schema, Relational model structure, Keys, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Closure, Canonical cover, Lossless joins , dependency preserving decomposition, Storage and File structure, File organization, Organization of records in files, indices-ordered, dense, sparse indices, secondary index, B+-trees, static hashing Query Processing, Overview, Measure of query cost, Join operation, Evaluation of expressions, Query Optimization, Join ordering, Estimating statistics of expression results, Materialized Views. Transactions, Concepts, Simple transaction model, Transaction atomicity and durability, Schedules-serial, concurrent, serializability. Concurrency Control, Lock based protocols, Deadlock handling, Timestamp-based Protocols, Recovery System: Failure classification, Storage structure, atomicity, algorithm, Unstructured database, Introduction to NoSQL, RDBMS vs NoSQL, NoSQL databases.

References:

1. Abraham Silberschatz, Henry Korth, S. Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2010.
2. Ramez Elmasri, Shamkant Navathe, Fundamentals of Database System, 6th Edition, Addison Wesley Publications Co., 2010.
3. Raghu Ramakrishnan, Johannes Gehrke, Database Management System, 3rd Edition, WCB/McGraw Hill Publisher, 2014.
4. Ivan Bayross, SQL, PL/SQL-The Programming Language of Oracle, 4th Edition, BPB Publications, 2010.
5. Shashank Tiwari, Professional NOSQL, Wiley, 2015.

MCA 4152 OBJECT ORIENTED PROGRAMMING [4 0 0 4]

Introduction: Object Oriented paradigm, Structured vs. Object Oriented Paradigm. Elements of Object Oriented Programming: Object, Classes, Encapsulation & data abstraction, Inheritance, Polymorphism. Programming Basics, Type conversion, Loops and Decision, Structures, Enumerated Data Types. Simple functions, Passing arguments to functions, Returning values from the functions, Reference arguments, Overloaded functions, Inline functions, Default arguments, variables and storage classes, Returning by reference. Objects and Classes. Array fundamentals, Arrays as class member data, Arrays of objects, String handling, Addresses and pointers, Pointers and arrays, Pointers and functions, Pointers and strings, Memory management using new and delete, Pointers to objects, Pointers to pointers. Operator Overloading, Data conversion, Inheritance, Virtual Functions & Polymorphism: Derived classes and Base classes, Levels of inheritance, Ambiguity in multiple inheritance, Containership, Classes within classes, Virtual functions, Friend functions, Static functions, this pointer. Files and Streams: Streams, String I/O, Character I/O, Object I/O, File pointers. Generic programming: Templates, Exception Handling & STL: Exception handling fundamentals, Exception handling options, STL: An overview, containers, vectors, lists, maps.

References:

1. Herbert Schildt, The Complete Reference C++, 4th Edition, Tata McGraw Hill, 2017.
2. Robert Lafore, Object Oriented Programming in C++, 4th Edition, Pearson Education, 2008.
3. Bjarne Stroustrup, A Tour of C++, 2nd Edition, Pearson Education, 2018.
4. Bjarne Stroustrup, The C++ Programming Language, 3rd Edition, Pearson, 2002.
5. E Balaguruswamy, Object Oriented Programming with C++, 7th Edition, Tata McGraw Hill, 2017.

MCA 4153 OPERATING SYSTEMS [3 0 0 3]

Introduction: Simple, multi-programmed batch systems, distributed systems, time-sharing & real time systems, hardware protection CPU Scheduling: Process concept, process state transitions, process control block, operations on processes, inter-process communication, scheduling criteria, scheduling algorithms, multilevel feedback queues. Concurrent Process: Mutual exclusion, Precedence graphs, critical section, Dekker's algorithm, hardware solution to mutual exclusion, semaphores, process synchronization with semaphores Memory management: Address binding, dynamic loading, dynamic linking, Overlays, swapping, contiguous allocation, paging, segmentation, segmentation with paging Virtual Memory: Demand paging, page replacement algorithms, thrashing, Algorithms thrashing Deadlocks: Deadlock characterization, resource allocation graph, deadlock prevention, avoidance, detection, Bakers algorithm and recovery from deadlock File Systems: Free space management, allocation methods, Directory structure, Disk scheduling methods.

References:

1. A Silberschartz, Peter B. Galvin and Greg Gagne, *Operating Systems Concepts*, 8th Edition, John Wiley & Sons, 2012.
2. H. M. Deitel, *An Introduction to Operating Systems*, 3rd Edition, Addison Wesley, 2004.
3. Milan Milankovic, *Operating Systems Concepts and Design*, 7th Edition, Tata McGraw Hill, 2004.

MCA 4154 SOFTWARE ENGINEERING [3 0 0 3]

Software Product, Process models and SRS: Various Process models, Development approaches and team structures, Requirements Functional and non-Functional, Software Document, Requirement Engineering Process, Feasibility Studies, Software Prototyping, Functional models, Structured Analysis, Design Concepts and Principles: Coupling, Cohesion, Span of control, Systems Engineering, Analysis Concepts, Design Process And Concepts, Modular Design, Monitoring And Control System, Cyclomatic complexity and good coding practices, Testing: Taxonomy Of Software Testing, Types Of S/W Test, Software Implementation Techniques, Software Validation, Static and Dynamic Analysis, Symbolic Equation, Mutation Analysis, Dynamic Testing, Unit Testing, White-box and Black-box Testing, Test Case Generation, Integration Testing, Bottom-up and Top-down Testing, System Testing, Function Testing, Performance Testing, Acceptance Testing, Installation Testing, Regression testing, Theoretical Foundation of Testing.

References:

1. Ian Sommerville, Software Engineering, 9th Edition, Pearson Education Asia, 2011.
2. Roger S. Pressman, Software Engineering – A practitioner's Approach, 8th Edition, McGraw-Hill International Edition, 2014.
3. Richard Fairley, Software Engineering Concepts, 9th Edition, McGraw-Hill Inc. New York, 2017.
4. Pankaj Jalote, Software Project Management in Practice, 7th Edition, Addison, Wesley, 2014.
5. Waman S Jawadekar, Software Engineering Principles and Practice, 3rd Edition, Tata McGraw Hill, 2010.

MCA 4161 DATABASE MANAGEMENT SYSTEM LAB [0 0 3 1]

Labs will be conducted as per the exercise given in the lab manual. Lab manual consists of exercises related to implementation/ realization of database concepts such as SQL, Queries, Join, Views, Advanced SQL, PL/SQL, Cursors, Functions and Procedures, Triggers

References:

1. Ivan Bayross, SQL, PL/SQL-The Programming Language of ORACLE, 4thEdition, BPB Publications, 2010.
2. SatishAsnani, Oracle Database 11g, PHI, 2010.3. Scott Urman, Ron Hardman and Michael Mclaughlin, Oracle Database 10g PL/SQL Programming, Ora

MCA 4162 LINUX PROGRAMMING LAB [0 1 3 2]

Labs will be conducted as per the lab manual. Lab manual consists of exercises related to implementation/realization of concepts discussed in the theory class. Also an addition Basic Linux Commands, the vi Editor and Simple Shell Programs, file-related commands and Shell Programs, Additional Linux Commands and Shell Programs, Processes, Process Scheduling, Process Synchronization and Deadlocks, Page replacement, File Handling, Disk Scheduling,

References:

1. Richard Blum and Christine Bresnahan, Linux Command Line Shell Scripting Bible, 3rd Edition, Wiley, 2015.
2. Mark Sobel. A Practical Guide to Linux commands Editor and shell programming, Prentice Hall, 2nd Edition, 2010.
3. A Silberschartz, Peter B. Galvin and Greg Gagne, Operating Systems Concepts, 8th Edition, John Wiley & Sons, 2012.

MCA 4163 OBJECT ORIENTED PROGRAMMING LAB [0 0 3 1]

Apply algorithms/ flow charts to develop programs using C++ programs on decision making, looping and switch conditions. Write programs to implement concept of structures, classes and objects, construction and destruction of objects, compile-time polymorphism with function and operator overloading. Develop programs for array of objects, manipulation using pointers, dynamic memory allocation. Write and execute C++ programs to implement different types of inheritance, dynamic binding, virtual functions, file I/O and exception handling.

References:

1. Herbert Schildt, The Complete Reference C++, 4th Edition, Tata McGraw Hill, 2017.
2. Robert Lafore, Object Oriented Programming in C++, 4th Edition, Pearson Education, 2008.
3. Bjarne Stroustrup, A Tour of C++, 2nd Edition, Pearson Education, 2018.
4. E Balaguruswamy, Object Oriented Programming with C++, 7th Edition, Tata McGraw Hill, 2017.
5. Paul J. Deitel and Harvey Deitel, C++ How to Program, 10th Edition, Pearson International, 2017.

SEMESTER II

MCA 4251 DATA ANALYTICS [4 0 0 4]

Introduction: data science, need for analytics, steps in data analysis projects, Data- sources of data, data sets, data warehouses, data types, privacy and confidentiality, samples vs. population, Data summarization and visualization: tables and graphs, Data Preprocessing: cleaning, transformation, dimensionality reduction, Data Analysis and Visualization: descriptive, inferential statistics, uni-variate and multi-variate analysis, Grouping: Cluster Analysis: distance measures, partitioning, hierarchical, density based methods, Market Basket Analysis, Association Analysis, Market Basket Analysis, Classifiers: Bayesian, k-nearest neighbor, neural network, Support Vector Machine, Decision Trees, Prediction: Regression models, Evaluating Classification and Predictive performance, ensemble methods, Anomaly Detection, Forecasting models, Applications in Data Analytics: Case studies, Web Mining, Text Mining, Business Intelligence, Supply Chain Analytics, Time series, Spatial Data Analysis.

References:

1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, John Wiley and Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Addison Wesley, 2005.

MCA 4252 DATA STRUCTURES AND ALGORITHMS [4 0 0 4]

Basic Concepts: Pseudocode, The Abstract Data Type, Model for an Abstract Data Type, ADT Implementation, Algorithm Efficiency, Time and Space Complexities, Asymptotic Notations. Recursion: Factorial – A

Case Study, Designing Recursive Algorithms, Recursive Examples. Stacks: Basic Stack Operations, Stack ADT, Stack Applications. Queues: Queue Operations, Queue ADT, Queue Applications. General Linear Lists: Basic Operations, List ADT, Singly-Linked List, Doubly Linked List, Circular Linked List. Introduction to Trees: Basic Concepts, Binary Trees. Binary Search Trees: Basic Concepts, BST Operations, Binary Search Tree ADT, BST Applications, AVL Search Trees: Basic Concepts, Balance Factor, AVL Tree ADT, Applications. Heaps: Basic Concepts, Heap Implementation, Heap ADT, Heap Applications. Multiway Trees: M-way Search Trees, B-Trees, B-Tree ADT, Simplified B-Trees, B-Tree Variations, Lexical Search Trees. Graphs: Basic Concepts, Operations, Graph Storage Structure, Graph ADT, Graph Algorithms – BFS and DFS. Sorting: Sort Concepts, Selection Sorts, Insertion Sorts, Exchange Sorts, External Sorts. Searching: List Searches, Hashed List Searches, Collision Resolution.

References:

1. Richard F. Gilberg and Behrouz A. Forouzan, Data Structures - A Pseudocode Approach with C, Second Edition, Cenage Learning, 2009.
2. S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2015.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Fundamentals of Algorithms, 2nd Edition, Universities Press, 2010.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms, (3e) PHI Publications, 2009.

MCA 4253 JAVA PROGRAMMING [4 0 0 4]

Java Development Kit (JDK), Java Run Time Environment (JRE), Java Virtual Machine (JVM), Bytecode. Java datatypes, keywords, operators, Type conversion, Arrays, Ragged arrays, ArrayLists. The Scanner class, The String Class, Command-line arguments, Variable-length arguments. Classes & Objects, Access specifiers, Constructors, Inner classes, Static fields and methods, Inheritance, calling superclass constructor, Method overriding, Dynamic method dispatch, Abstract class, preventing inheritance: final classes and methods, The Object class, Wrapper classes, Autoboxing and Unboxing. Enumeration, Annotation. Packages, creating and importing packages, Interfaces, partial implementations, Object cloning, Cloneable interface. Exception handling, Exception types, throws & finally statements, User-defined exceptions. Multithreaded programming, The Java thread model, The Thread class and runnable interface, creating multiple threads, Synchronization, Inter-thread communication. Garbage collection, finalize method. Streams and Files. The stream classes, The Byte Streams, The Character streams. Event handling, event sources, event listeners, event classes. The Collection classes, generic programming, defining a generic class, creating a generic method, Database programming - JDBC packages.

References:

1. Herbert Schildt, Java The Complete Reference, 11th Edition, McGraw Hill, 2019.
2. Cay S. Horstmann. Core Java: Volume I - Fundamentals. 11th Edition, Pearson Education, 2018.
3. Cay S.Horstmann, Core Java: Volume II – Advanced Features, 11th Edition, Pearson Education, 2019.
4. Herbert Schildt and Dale Skrien, Java Fundamentals, Tata McGraw-Hill Education, 2015.

MCA 4254 WEB TECHNOLOGIES [4 0 0 4]

Introduction to HTML, Structure of HTML Document, Semantics of HTML Elements and Attributes, HTML Tables and Forms, Introduction to CSS, Types of Styles, Selectors, Style Cascade, The Box Model, Text Styling, Background Styling, Table Styling, Box Styling, Normal Flow of Elements, Positioning and Layering Elements, Floating Elements, Approaches to CSS Layout, Responsive Design, Introduction to Client-Side Programming with Javascript, Basics of Programming, Data Types and Objects, Javascript Events, Form Validation, Introduction to Server-Side Programming with PHP, What is Server-Side Development, PHP Controls, PHP Functions, PHP Arrays, Superglobal Arrays, File Uploading, Server-Side Validation, PHP Error and Exception Handling, State Management using Cookies and Sessions, JSON, Database Operations with PHP, Introduction to AJAX, Angular: Fundamental Architecture, Set-Up and Deployment, Components, Templates, Binding, Forms and Web API.

References:

1. Randy Connolly, Ricardo Hoar, *Fundamentals of Web Development*, 1st Edition, Pearson Education India, 2015.
2. Luke Welling, Laura Thomson, *PHP and MySQL Web Development*, 5th Edition, Pearson Education, 2016.
3. Nicholas C Zakas, *Professional JavaScript for Web Developers*, 3rd Edition, Wrox/Wiley India, 2012.
4. John Kocer, “Angular 7: By Example (Part One Book 1)”, 2019.
5. Nate Murray, Felipe Coury, Ari Lerner, Carlos Taborda, *ng-book- The Complete Book on Angular*, 2019.

MCA 4261 DATA STRUCTURES AND ALGORITHMS LAB [0 0 3 1]

Labs will be conducted as per the lab manual. Lab manual consists of exercises related to implementation/realization of concepts discussed in the theory class. The concepts included are Searching and Sorting algorithms, Stacks and Queues, Conversion of mathematical expressions, Evaluation of mathematical expressions, Singly- and doubly-linked lists, Trees, Graph algorithms.

References:

1. Richard F. Gilberg and Behrouz A. Forouzan, Data Structures – A Pseudocode Approach with C, Second Edition, Cenage Learning, 2009.
2. S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2015.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Fundamentals of Algorithms, 2nd Edition, Universities Press, 2010.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms, 3rd Edition, PHI Publications, 2009.

MCA 4262 JAVA PROGRAMMING LAB [0 0 3 1]

Labs will be conducted as per the lab manual. Lab manual consists of exercises related to implementation/realization of concepts that include: basic Java Programming, Arrays, Strings, Inheritance, Exception handling, Packages, Multithreaded programming, Collections, File handling and JDBC.

References:

1. Herbert Schildt, Java The Complete Reference, 11th Edition, McGraw Hill, 2019.
2. Cay S. Horstmann. Core Java: Volume I - Fundamentals. 11th Edition, Pearson Education, 2018.

3. Cay S.Horstmann, Core Java: Volume II – Advanced Features, 11th Edition, Pearson Education, 2019.
4. Herbert Schildt and Dale Skrien, Java Fundamentals, Tata McGraw-Hill Education, 2015.

MCA 4263 WEB TECHNOLOGIES LAB [0 0 3 1]

The students are required to implement and realize web page development. The static web page development using HTML elements including text, images, links and tables. The web forms are modelled and designed using necessary form-based elements. Responsive web layouts are implemented using media elements and advanced CSS. Dynamic HTML concepts are realized through DOM implementation using client-side JavaScript. The data-driven server-side applications are implemented on server-side environment using PHP and Angular JS.

References:

1. Randy Connolly, Ricardo Hoar, *Fundamentals of Web Development*, 1st Edition, Pearson Education India, 2015.
2. Luke Welling, Laura Thomson, *PHP and MySQL Web Development,* 5th Edition, Pearson Education, 2016.
3. Nicholas C Zakas, *Professional JavaScript for Web Developers*, 3rd Edition, Wrox/Wiley India, 2012.
4. John Kocer*, "Angular 7: By Example (Part One Book 1)",* 2019.
5. Nate Murray, Felipe Coury, Ari Lerner, Carlos Taborda, *ng-book- The Complete Book on Angular*, 2019.

SEMESTER III

MCA 5151 COMPUTER NETWORKS [4 0 0 4]

Basic concepts of computer networks, need for layered architecture and comparison between ISO/OSI, TCP/IP layered models. Significance of Datalink layer and protocols. Network layer functionalities, classful, classless IP addressing, address allocation and role of forwarding module in forwarding the packet using routing table. Roles played by IP, ARP, RARP, ICMP & IGMP protocols in network layer. Discussing different inter-domain and intra-domain routing algorithms which help in building routing tables. Importance of transport layer in achieving process-to-process communication. Insight of connection oriented protocol TCP and connectionless protocol UDP. Features of TCP in achieving flow control, error control and congestion control. Requirement of different timers in TCP. Drawbacks of IPv4 addressing and new IP addressing scheme IPv6. Issues to be considered in migrating from IPv4 to IPv6. Introduction to application layer, a client/server application program and a case study client-server application program-Dynamic Host Configuration Protocol (DHCP).

References:

1. Behrouz A. Forouzan, TCP/IP Protocol Suite, 4th Edition, Tata McGraw Hill, 2010.
2. Tannenbaum, A.S, Computer Networks, 5th Edition, Prentice Hall of India EE Edition, 2011.
3. Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, Tata McGraw Hill, 2013.
4. Leon Garcia and Widjala, Communication Networks, 5th Edition, Tata McGraw Hill, 2017.

MCA 5152 MACHINE LEARNING [4 0 0 4]

Introduction, Applications, Probability: Random Variables, Supervised Learning: Learning a Class, Vapnik-Chervonenkis Dimension, PAC Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Supervised Machine Learning, Bayesian Decision Theory: Classification, Losses and Risks, Discriminant Functions, Utility Theory, Association Rules, Parametric Methods: Maximum Likelihood Estimation, Evaluating an Estimator: Bias and Variance, Bayes' Estimator, Parametric Classification, Regression, Tuning Model Complexity: Bias/Variance Dilemma Model Selection Procedures, Dimensionality Reduction: Subset Selection, PCA, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis, Clustering: Mixture Densities, k-Means Clustering, Expectation-Maximization Algorithm, Latent Variable Models, Supervised Learning after Clustering, Hierarchical Clustering, Nonparametric Methods: Density Estimation, Generalization to Multivariate Data, Nonparametric Classification, Condensed Nearest Neighbor, Nonparametric Regression: Smoothing Models, Smoothing Parameter, Decision Trees: Univariate Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees, Linear Discrimination: Generalizing Linear Model, Geometry of Linear Discriminant, Pairwise Separation, Parametric Discrimination, Gradient Descent, Logistic Discrimination, Discrimination by Regression, Multilayer Perceptrons: Perceptron, Training a Perceptron, Learning Boolean Functions, MLP as a Universal Approximator, Backpropagation Algorithm, Training Procedures, Tuning Network Size, Bayesian View of Learning, Dimensionality Reduction, Learning Time.

References:

1. Ethem Alpaydin, Introduction to Machine Learning, 3rd Edition, PHI Learning Private Limited, 2018.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, "Foundations of Machine Learning, MIT Press, 2012.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

MCA 5161 MACHINE LEARNING LAB [0 0 3 1]

Labs will be conducted as per the lab manual. Lab manual consists of exercises related to implementation/realization of concepts discussed in the theory class. The concepts included are Probability-based problems, Dimensionality reduction, Supervised Learning, Regression, Ensemble methods – classifiers and clusters and Unsupervised Learning.

References:

1. Ethem Alpaydin, Introduction to Machine Learning, 3rd Edition, PHI Learning Private Limited, 2018.
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, "Foundations of Machine Learning, MIT Press, 2012.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

MCA 5162 MOBILE APPLICATION DEVELOPMENT LAB [0 1 3 2]

Labs will be conducted as per the lab manual. Lab manual consists of exercises related to implementation/realization of concepts discussed in the theory class. Also an additional tutorial class will be conducted as per the prerogative of the faculty who is handling the lab.

References:

1. Bill Phillips, Chris Stewart and Kristin Marsicano, Android Programming: The Big Nerd Ranch Guide, 3rdEdition, Big Nerd Ranch Guides, 2017.

2. Dawn Griffiths and David Griffiths, Head First Android Development: A Brain-Friendly Guide, 2nd Edition, O'Reilly Media, 2017.
3. Neil Smyth, Android Studio 3.0 Development Essentials, 1st Edition, CreateSpace Independent Publishing Platform, 2017.
4. Ian F. Darwin, Android Cookbook: Problems and Solutions for Android Developers, 2nd Edition, O'Reilly Media, 2017.
5. AntonisTsagaris, Android Development for Gifted Primates: A Beginner's Guide (Guides for Gifted Primates Book 1), 2018.

MCA 5163 NETWORK LAB [0 1 3 2]

Labs will be conducted as per the lab manual. Lab manual consists of exercises related to implementation/realization of inter-process communication and socket programming concepts. Also an additional tutorial class will be conducted as per the prerogative of the faculty who is handling the lab.

References:

1. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, Unix Network Programming, The Sockets networking API, Volume-1, 3rd Edition, Prentice Hall of India EE Edition, 2010.
2. Richard Stones, Neil Matthew, Beginning Linux Programming, 4th Edition, Wiley, 2007.

MCA 5164 SEMINAR [0 0 6 2]

It is mandatory for the students to give two technical seminars on trending technical topics, one individual and one group. Students have to prepare a report to be submitted a week ahead of the seminar. Groups are created and students are informed about the groups they belong to in the previous semester. The seminar would be graded based on the presentation skills and technical content.

SEMESTER IV

MCA 5298 PROJECT WORK [0 0 0 12]

Students are required have to undertake full time projects which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 16 weeks. There will be a mid-term evaluation of the project work done after about 8 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term and end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

MCA 5026 BIG DATA ANALYTICS [3 0 0 3]

Introduction to Big Data: evolution, structuring, elements, big data analytics, distributed and parallel computing for big data, Hadoop, Cloud computing and big data, in-memory computing technology for big data, Big Data Stack, Virtualization and Big Data, Hadoop: ecosystem, Hadoop Distributed File System (HDFS), MapReduce: MapReduce Framework, optimizing MapReduce jobs, MapReduce Applications, Understanding YARN architecture, HBase, Exploring Hive, Analyzing data with Pig, Using Oozie, Introduction to Mahout, role of HBase in Big Data Processing, RHadoop: Data Analysis Using the MapReduce Technique in RHadoop, Spark: Core Concepts, Spark's Python and Scala shells, Programming with RDD: RDD Operations, Passing Functions to Spark, Common Transformations and Actions, Mining Data Streams: Streams Concepts, stream Data Model and Architecture, stream computing, filtering Streams, estimating Moments, decaying window, Real time Analytics Platform (RTAP) Applications, Case studies: Real Time Sentiment Analysis, Stock Market Predictions.

References:

1. Vignesh Prajapathi, Big Data Analytics with R and Hadoop, Packt Publishing, 2013.
2. Holden Karau, Andy Konwinski , Patrick Wendell, Matei Zaharia, Learning Spark: Lightning-Fast Big Data Analysis, 1st Edition, O'Reilley Media Inc, 2015.
3. Michael Minnelli, Michele Chambers, Big Data Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley India Pvt. Ltd., 2013.
4. Arvind Sathi, Big Data Analytics, MC Press, LLC, 2012.

MCA 5027 CLOUD COMPUTING [3 0 0 3]

Cloud Computing Overview: Technologies for Network-Based System, System Models for Distributed and Cloud Computing, NIST Cloud Computing Reference Architecture. Cloud Models: Characteristics, Cloud Services models (IaaS, PaaS, SaaS), Cloud Deployment model, Computing on demand, Cloudonomics: Economics of Cloud Computing, The 10 Laws of Cloudonomics, Laws of Behavioral Cloudonomics, Service level agreements, Case study on SLA; Virtualization: Basics of Virtualization, Types of Virtualization, Implementation Levels of Virtualization, Virtualization Structures, Tools and Mechanisms, Virtualization of CPU, Memory, I/O Devices, Virtual Clusters and Resource management, Virtualization for Data-center Automation, Programming Model: Parallel and Distributed Programming Paradigms, MapReduce, Twister and Iterative MapReduce, Hadoop Library from Apache, Mapping Applications, Programming Support, Google App Engine, Amazon AWS, Cloud Software Environments, Eucalyptus, Open Nebula, OpenStack, Aneka, CloudSim; Security In The Cloud: Security Overview, Cloud Security Challenges and Risks, Software-as-a-Service Security, Security Governance, Risk Management, Security Monitoring, Security Architecture Design, Data Security, Application Security , Virtual Machine Security, Identity Management and Access Control, Autonomic Security.

References:

1. Sartaj Sahani, Fundamentals of Data structures using C, 2nd Edition, Silicon Press, 2007.
2. J. P. Trembly and Sorenson, An Introduction to Data Structures with Applications, 2nd Edition, McGraw Hill, 36th Reprint, 2008.
3. J. E. Aho, A.V. Hopcroft and Ullman, Data structures and algorithm, 4th Edition, Addison Wesley, 2009.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, 3rd Edition, PHI Publications, 2009.

MCA 5028 COMPUTATIONAL INTELLIGENCE [3 0 0 3]

Artificial Neural Networks: The Artificial Neuron, Activation Functions, Artificial Neuron Geometry, Artificial Neuron Learning; Supervised Learning, Neural Network Types, Supervised Learning Rules; Unsupervised Learning, Hebbian Learning Rule, Principal Component Learning Rule, Self-Organizing Feature Maps; Reinforcement Learning, Learning through Awards, Model-Free Reinforcement Learning Model, Neural Networks and Reinforcement Learning; Performance Issues, Performance Measures, Analysis of Performance, Performance Factors. Evolutionary Computation: Generic Evolutionary Algorithm, Representation-the Chromosome, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary Computation Versus Classical Optimization, Genetic Algorithms, Genetic Programming, Evolution Strategies. Swarm Intelligence: Basic Particle Swarm Optimization, Social Network Structures, Basic Variations, Basic PSO Parameters, Single-Solution Particle Swarm Optimization, Ant Colony Optimization; Fuzzy Systems: Fuzzy Sets, Fuzzy Logic and Reasoning, Fuzzy Inferencing, Fuzzy Controllers, Mamdani Fuzzy Controller, Takagi-Sugeno Controller, Rough Sets.

References:

1. Andries P. Engelbrecht, Computational Intelligence, 2nd Edition, Wiley Publications, 2007.
2. Russell Eberhart and Yuhui Shi, Computational Intelligence: Concepts to Implementations, Morgan Kaufmann Publishers, 2009.
3. Janusz Kacprzyk, Witold Pedrycz, Springer Handbook of Computational Intelligence, Springer, Heidelberg, 2015.
4. Lakhmi Jain, Philippe De Wilde, Practical Applications of Computational Intelligence Techniques, Springer, New York, 2001.

MCA 5029 COMPUTER ORGANISATION AND ARCHITECTURE [3 0 0 3]

Number Systems and Conversions, Boolean Algebra and Simplifications, Minimization of Boolean Functions, Karnaugh Map, Quine McClusky Method. Logic Gates: NAND NOR implementation. Design of Circuits: Adder /Subtracter , Encoder, Decoder, MUX /DEMUX – Comparators, Flip flops, Triggering, Master: Slave Flip Flop, State Diagram and Minimization, Counters, Registers Functional Units, Basic Operational Concepts: Bus structures, Performance and Metrics, instruction and instruction sequencing, Hardware Software Interface, Addressing modes, Instruction Sets, RISC and CISC, ALU Design, Fixed point and Floating point Processor basics, CPU Organization, Data Path Design, Control Design, Basic concepts, Hardwired control, Micro Programmed control, Pipe control, Hazards super scale operations Memory technology, Memory Systems: Virtual Memory, Caches, Design Methods, Associative memories, Input /output system, Programmed I/O, DMA and interrupts, I/O devices and Interfaces, Fundamental of Parallel Processing: Introduction, parallelism in conventional computers, general classification of computer architecture, Array processors: systolic arrays and wave front array processors, processing: Basic concepts, Arithmetic, pipelines, multiprocessors: Single bus, Multi-bus, cross bar, multiport memory.

References:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, 6th Edition, Tata McGraw Hill, 2012.
2. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann, 2010.
3. Morris Mano, Digital Design, 5th Edition, Prentice Hall of India, 2013.
4. John P. Hayes, Computer Architecture and Organization, 3rd Edition, Tata McGraw Hill, 2012.
5. William Stallings, Computer Organization & Architecture – Designing for Performance, 10th Edition, Pearson Education, 2016.

MCA 5030 CYBER FORENSICS [3 0 0 3]

Introduction to Computer Forensics, Computer Forensics in Law enforcement, Computer Forensics assistance to human resources, Computer Forensics services, Benefits of Professional Forensics methodology, Steps taken by Computer Forensics specialists, Who can use Computer Forensics evidence, Types of Computer Forensics Technology, Types of law enforcement, Occurrence of Cyber Crime, Cyber Detectives, Fighting Cyber Crime with Risk-Management Techniques, Computer Forensics Investigation Services, Forensics process Improvement, Data Recovery, The role of Back-up in Data Recovery, The Data Recovery solutions, Evidence, Collection options, Obstacles, Types of Evidence, The rules of Evidence, Volatile Evidence, Procedure, Collection and Archiving, Methods of collection, Artifacts, Collection Steps, Controlling Contamination, Preserving The Digital Crime Scene, Computer Evidence processing steps, Legal Aspects of Collecting and preserving Computer Forensic Evidence, Special needs of Evidential Authentication, Practical consideration, Practical Implementation, How to become a Digital Detective, Useable File Formats, Unusable File Formats, Converting Files, Network Forensic scenario, A technical approach, Destruction of E-mail, Damaging Computer Evidence, Documenting the intrusion on destruction of data.

References:

1. John R. Vacca, Computer Forensics, Computer Crime Scene Investigation,3rd Revised Edition, Jones& Bartlett Publishers,Inc., 2019.
2. Bill Nelson, Amelia Phillips, Guide to Computer Forensics and Investigations: Processing Digital Evidence, Fifth Edition, CENGAGE Learning, 2015.
3. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, Real Digital Forensics, Addison Wesley Pearson Education, 2006.

MCA 5031 DESIGN AND ANALYSIS OF ALGORITHMS [3 0 0 3]

Introduction: Need for Algorithmic Thinking, Need for Algorithm Efficiency, Fundamental Stages of Problem Solving, Classification of Algorithms. Basics of Algorithm Analysis: Basics of Algorithm Complexity, Introduction to Time Complexity, Analysis of Iterative Algorithms, Rate of Growth, Asymptotic Analysis and Space Complexity Analysis. Mathematical Analysis of Recursive Algorithms: Introduction to Recurrence Equations, Formation of Recurrence Equations, Techniques for Solving Recurrence Equations, Divide-and-conquer Recurrences. Brute Force Approaches: Introduction, Computational Geometry Problems, Exhaustive Searching. Divide-and-conquer Approach: Introduction, Merge Sort, Quick Sort, Closest-pair Problem. Greedy Algorithms: Introduction to Greedy Approach, Suitability of Greedy Approach, Coin Change Problem, Scheduling Problems, Knapsack Problem, Optimal Graph Problems. Dynamic Programming: Basics of Dynamic Programming, Fibonacci Problem, Computing Binomial Coefficients, Floyd-Warshall All Pairs Shortest-path problem, Bellman-Ford Algorithm, Traveling Salesperson Problem, Knapsack Problem. Backtracking: Introduction, Basics of Backtracking, N-queen Problem, Sum of subsets, Vertex Coloring Problem, Hamiltonian Circuit Problem. Branch-and-Bound technique: Introduction, Search Techniques for Branch-and-Bound Technique, Traveling Salesperson Problem, Knapsack Problem. Basics of Computational Complexity: Introduction to Computational Complexity, Algorithmic Complexity, Complexity Classes, Theory of NP-complete Problems, Example Problems for Proving NP-completeness.

References:

1. S. Sridhar, Design and Analysis of Algorithms, 1st Edition, Oxford University Press, 2015.
2. Richard F. Gilberg and Behrouz A. Forouzan, Data Structures – A Pseudocode Approach with C, 2nd Edition, Cenage Learning, 2009.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran,

Fundamentals of Algorithms, 2nd Edition, Universities Press, 2010.

4. Thomas H. Cormen, Charles, E. Leiserson, Ronald L. Rivest and Clifford Stein Introduction to Algorithms, 3rd Edition, PHI Publications, 2009.

MCA 5032 ETHICAL HACKING [3 0 0 3]

Introduction to Ethical Hacking: Important Terminologies, Penetration Testing and Tools: Phases involved in Ethical Hacking, Types of Hackers. Foundations of Information Security, Network Security: Introduction, Protocols, IP Security, SSL/TLS, DNS, Firewalls, Intrusion Detection, Linux Basics: File structure, permissions, scheduler, users, backtrack, Footprinting and reconnaissance, Social Engineering, Trojans, backdoors, viruses and worms, Web Hacking, Attacking the authentication, Brute force and dictionary attacks, types of authentication, Sniffers, Introduction, Types of sniffing, MITM attacks, ARP attacks, DOS attacks, SQL injection and Buffer overflows.

References:

1. Harper Allen, Gray Hat Hacking: The Ethical Hackers HandBook, 3rd Edition, McGraw Hill, 2011.
2. Rafay Baloch, Ethical Hacking and Penetration Testing Guide, Auerbach Publications, 2014.
3. Himanshu Sharma, Kali Linux - An Ethical Hacker's Cookbook, Packt Publishing Limited, 2017.
4. Dafydd Stuttard and Marcus Pinto, The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, 2nd Edition, 2011.
5. Lester Evans, Ethical Hacking: The Ultimate Guide to Using Penetration Testing to Audit and Improve the Cybersecurity of Computer Networks for Beginners, Including Tips on Social Engineering, 2019.

MCA 5033 GAME PROGRAMMING [3 0 0 3]

3D Graphics for game programming: Coordinate Systems, Ray Tracing, Modeling in Game Production, Vertex Processing, Rasterization, Fragment Processing and Output Merging, 3D Transformations, Quaternions, 3D Modeling and Rendering, Ray Tracing, Shader Models, Lighting, Color, Texturing, Camera and Projections, Culling and Clipping, Character Animation, Physics-based Simulation, Scene Graphs. Game engine design: Game engine architecture, Engine support systems, Resources and File systems, Renderers, Software Rendering, Hardware Rendering, and Controller based animation, Spatial Sorting, Level of detail, collision detection, standard objects, and physics, Human Interface devices, Collision and rigid body dynamics, Game Programming: Application layer, Game logic, Game views, managing memory, controlling the main loop, loading and caching game data, User Interface management, Game event management, Introduction to Games development tools: Milk Shape - 3D, Unity – 3D, Light wave 3D.

References:

1. Mike Mc Shaffrfy and David Graham, Game Coding Complete, 4th Edition, Cengage Learning, PTR, 2012.
2. Jason Gregory, Game Engine Architecture, CRC Press / A K Peters, 2009.
3. Kenneth C. Finney, Advanced 3D Game Programming All in One, Premier Press, 2011.
4. Mike McShaffry, David Rez Graham, Game Coding Complete, Course Technology PTR, 2012.
5. Joseph Hocking, Unity in Action: Multiplatform Game Development in C# with Unity 5, 2nd Edition, Manning Publications, 2018.

MCA 5034 INFORMATION AND NETWORK SECURITY [3 0 0 3]

Introduction: The OSI Security Architecture, Security Attacks, Services and Mechanisms, Model for Network Security, Number theory Cryptographic Hash Functions, Digital Signatures, System Security, Symmetric Encryption and Message Confidentiality, Substitution ciphers, Stream ciphers, Public-key cryptography and Message Authentication, Key Distribution and Authentication, Transport Layer Security, Wireless Network Security, E-mail Security, IP Security, Security Management Systems, Need for IT Security, Intrusion Prevention and Detection Systems, Cyber Security.

References:

1. William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson Education, 2017.
2. William Stallings, Network Security Essentials: Applications and Standards, 6th Edition, Pearson Education, 2014.
3. Atul Kahate, Cryptography and Network Security, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, 2013.
4. Bruce Schneier, Applied Cryptography: Protocols, Algorithms and Source Code in C, 2nd Edition, Wiley Publications, 2007.
5. V. K. Pachghare, Cryptography and Information Security Paperback, 2nd Edition, PHI Publications, 2015.

MCA 5035 INFORMATION STORAGE MANAGEMENT [3 0 0 3]

Information storage, evolution of storage architecture, ILM. Storage System Environment: Disk components and performance measurement. Data Protection RAID: techniques, types, Intelligent storage system. Block: based Storage System: Components of block: based storage system. Storage provisioning and storage tiering, File-based Storage System: NAS, file sharing methods, File-level virtualization, Object-based and Unified Storage: Key features of OSD, Content addressed storage (CAS), unified storage architecture, Software-defined Storage: architecture of software-defined storage, Fibre Channel SAN: components and architecture, Internet Protocol SAN, iSCSI protocol, network components, and connectivity, link and switch aggregation, and VLAN, Fibre Channel over Ethernet SAN: FCoE SAN, FCoE SAN connectivity. Introduction to Business Continuity, Backup and Archive, Replication, Storage virtualization: forms of virtualization, EMC Products and tools: A Case study CLARiiON Architecture, Snap view, Mirror view, Power path and SANCOPY.

References:

1. Marc F. Osborne, Building Storage Networks, 2nd Edition, Tata McGraw Hill, 2001.
2. Marc Farley, Storage Networking Fundamentals, 1st Edition, CISCO Press, 2004.
3. Robert Spalding, Storage Networks: The Complete Reference, Tata McGraw Hill, 2003.
4. G. Somasundaram, A. Shrivastava, EMC Corporation, Information Storage and Management, 2nd Edition, Wiley Publication, 2012.

MCA 5036 INTERNET OF THINGS [3 0 0 3]

Internet of Things, Physical Design, Logical Design, IoT Enabling Technologies, IoT Levels & Deployment Templates, Domain Specific IoTs, IoT and M2M, IoT System Management, M2M high-level ETSI architecture, IETF architecture for IoT, OGC architecture, IoT reference model, Domain model, information model, functional model, communication model, IoT reference architecture, Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Unified Data Standards, Protocols: IEEE 802.15.4, BACNet Protocol, Modbus, Zigbee Architecture, Network layer, 6LowPAN, CoAP, Security, Building IOT with RASPERRY PI: IoT Systems, Logical Design using Python, IoT Physical Devices and Endpoints, IoT Device, Building blocks, Raspberry Pi, Board, Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python, other IoT Platforms, Arduino.

References:

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, Universities Press, 2015.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian, Architecting the Internet of Things, Springer, 2011.
3. Jan Ho, ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, David Boyle, From Machine-to-Machine to the Internet of Things-Introduction to a New Age of Intelligence, Elsevier, 2014.
4. Honbo Zhou, The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
5. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things – Key applications and Protocols, Wiley, 2012.

MCA 5037 MANAGEMENT INFORMATION SYSTEM [3 0 0 3]

System Concepts, Definitions, Computer based user machine system, Open and Close Systems, Integrated system, Need for a database, Utilization of models, Evolution, Subsystems, Organizational subsystems, Activities subsystems, Organizational Structure, Basic model, Hierarchical, Specialization, Formalization, Centralization, Modifications of basic organizational structure, Project organization, Lateral relations, Matrix organization, Organizational culture and power organizational change, Structure of MIS, Operating elements, Physical components, Processing functions, Outputs, MIS support for decision making, Structured programmable decisions, Unstructured non-programmable decisions, MIS structure based on management activity and organizational functions, MIS pyramid structure, Synthesis of MIS structure, Development and Management, A contingency approach to choosing an application, Developing strategy, Lifecycle definition stage, Lifecycle development stage, Lifecycle installation and operation stage.

References:

1. Gordan B Davis, Margrethe H. Olson, Management Information Systems: Conceptual foundations, Structure and development, 5th Edition, Tata-Mc Graw Hill International Book Company, 2012.
2. E.Wainright Martin, Carol V. Brown, Denial W. DeHayes, Jeffrey A. Hoffer, William C Perki vns, Managing Information Technology, 7th Edition, Prentice Hall International, 2011.
3. A.K. Gupta, Management Information Systems, 4th Edition, S. Chand and Company Ltd., 2010.

MCA 5038 NOSQL DATABASE SYSTEMS [3 0 0 3]

The significance of Relational databases, impedance mismatch, the emergence of NoSQL, definition and history, Aggregate model, Four Types of NoSQL Database, scheme less databases, materialized Distribution models-single server, Sharding, Master-Slave replication, Peer-to-Peer Replication, combinations, relaxation consistency, Brewer's cap theorem, Document Databases, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, CRUD operations using Mongo DB, Column- oriented NoSQL databases HBASE, a, Architecture of HBASE, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, CRUD operations using HBase/Cassandra. NoSQL Key/Value databases Redis, Key-Value Databases, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, CRUD operations using Redis, Graph Databases, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, CRUD operations using Neo4j, Schema migrations, schema changes in RDBMS, schema changes in NoSQL, Incremental migration, migration in Graph Databases, Case Study-Document Database MongoDB.

References:

1. Pramod J Sadalage, Martin Fowler, NoSQL Distilled, Addison-Wesley, 1st Edition, 2012.
2. Shashank Tiwari, Professional NOSQL, John Wiley & Sons Inc., 1st Edition, 2011.
3. Kyle Banker, Peter Bakkum, Shaun Yerch, Douglas Garrett, Tim Hawkins, MongoDB in Action, 2nd Edition, Manning Publications, 2016.
4. Lans George, HBase: The Definitive Guide, 1st Edition, O'Reilly Media, Inc., 2011.
5. Ian Robinson, Jim Webber and Emil Eifrem, Graph Databases, 2nd Edition, O'Reilly Media, Inc., 2015.

MCA 5039 OBJECT ORIENTED ANALYSIS AND DESIGN [3 0 0 3]

Complexity: Structure, Five Attributes of a complex system, The Object Model: Evolution, Foundations, Elements and Applications, Classes and Objects: Nature and relationship between objects, Nature and relationship between classes. Importance of classification, Notation: Unified modelling language, Class diagram, Use case diagram, Sequence diagrams, Activity diagram, Object Diagrams, Component diagram, Deployment diagram and Package diagrams, The Process: First Principles, The Macro Process: The Software Development Lifecycle, The Micro Process: The Analysis & Design Process, Pragmatics: Management & Planning, Staffing, Release Management, Reuse, Quality Assurance and Metrics, Documentation, Tools and special tools, Risks of Object Oriented Development, Applications: System Architecture: Satellite Based Navigation, Control System: Traffic Management, Artificial Intelligence: Crptyanalysis, Web Application: Vacation Tracking System.

References:

1. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen and Kelli A. Houston, Object-Oriented Analysis & Design With Applications, 3rd Edition, Pearson Education Inc., 2007.
2. Grady Booch, Object-Oriented Analysis And Design With Applications, 2nd Edition, Pearson Education Inc., 2007.
3. Michael Blaha and James R Rumbaugh, Object-Oriented Modeling & Design with UML 2.0, 2nd Edition, Pearson Education, India, 2007.
4. Brahma Dathan, Sarnath Ramnath, Object-Oriented Analysis, Design and Implementation, Universities Press, 2013.
5. Grady Booch, James Rumbaugh, Ivar Jacobson, The Unified Modeling Language Reference Manual, 2nd Edition, Addison Wesley, 2004.

MCA 5040 OPTIMIZATION TECHNIQUES [3 0 0 3]

Linear Programming: Graphical Solution, Simplex Method, Big M Method, Transportation and Assignment Model. Network flow: Max Flow - Min Cut Theorem, Ford – Fulkerson's algorithm and Edmond Karp's algorithm, CPM and PERT Networks. Dynamic Programming: Introduction, Equipment Replacement Model, Allocation Problem, Inventory Models, Production Scheduling. Decision Theory: Decision under certainty: Analytic Hierarchy Process (AHP), decision under risk: decision trees, expected value criterion, Variations of the Expected value criterion, decision under uncertainty: Laplace, MinMax, Savage, Hurwicz method. Game Theory: Introduction, Minmax – Maxmin pure strategies, Optimal solution of two person zero sum games, solution of mixed strategy games, 2 x 2 games, 2 x n games, m x 2 games. Heuristics and approximation algorithms: approximation algorithms for Travelling Salesman Problem (TSP), Vertex cover problem. Randomized local search heuristics: Evolutionary algorithm for optimization. Application to real world optimization problems

References:

1. Taha H, Operation Research: An Introduction, 10th Edition, McMillan, 2017.
2. Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin, Network Flows: Theory, Algorithms, and Applications, Pearson New International Edition, 2014.
3. Teofilo F. Gonzalez, Handbook of Approximation Algorithms and Metaheuristics, Chapman & Hall/CRC Computer and Information Science Series, 1st Edition, 2007.
4. S.S. Rao, Engineering Optimization: Theory and Practice, New Age International Pvt. Ltd., New Delhi, 2013.

MCA 5041 PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS [3 0 0 3]

Introduction: Definitions of data sets for Pattern Recognition (PR), Different paradigms of PR, Representations of Patterns and Classes, Metric and Non-metric proximity measures, Applications of PR, Feature extraction and feature selection: Feature extraction, different approaches to feature selection, Feature ranking. Statistical Decision Making: Introduction, Bayes theorem, multiple features, conditionally independent features, decision boundaries, the leaving-one-out technique, characteristic curves, estimating the composition of populations. Naïve Bayes classifier, Bayesian Belief Networks, Supervised and unsupervised Classification: Introduction to supervised and unsupervised classifications, Classification in High dimension, Random forests, SVM classifications. Introduction to clustering, clustering large datasets and combination of classifiers.

References:

1. Devi V. S, Murthy M. N, Pattern Recognition: An Introduction, Universities Press, Hyderbad. 2011.
2. Earl Gose, Richard Johnsonbaugh and Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall of India, 2003.
3. R.D. Duda, P.E. Hart and D.G. Stork, Pattern Classification, 2nd Edition, John Wiley Inc., 2001.

MCA 5042 SEMANTIC WEB [3 0 0 3]

Semantic Web Vision: technologies, layered approach, Structured Web Documents: XML, Describing Web Resources: RDF-data model, syntaxes, RDFS-adding semantics, RDF schema, RDF and RDF schema in RDFS, Axiomatic schematics for RDF and RDF schema, Direct inference system for RDF and RDFS, querying in SPARQL, Web Ontology Language: OWL and RDF/RDFS, Requirement of ontology language, Compatibility of OWL2 features, Logic and Inference: Rules, monotonic rules, OWL2 RL, Rule interchange format (RIF), Description Logic Programs (DLP), Semantic Web Rules Language(SWRL) , Rule Markup Language (RuleML), Ontology Engineering: constructing ontologies, reusing existing ontologies, semiautomatic ontology acquisition, Ontology Mapping, On-To-Knowledge Semantic Web Architecture.

References:

1. Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra, A Semantic Web Primer, MIT Press, 2012.
2. Michael C. Daconta, Leo J. Obrst and Kevin T. Smith, The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management, Wiley, 2003.
3. Jorge Cardoso, Martin Hepp and Miltiadis D. Lytras, The Semantic Web: Real-World Applications from Industry, Springer, 2008.

MCA 5043 SERVICE ORIENTED ARCHITECTURE [3 0 0 3]

Fundamental SOA, Common Characteristics, misperception, tangible benefits and pitfalls of adopting; SOA timeline, The continuing evolution of SOA, roots of SOA, Comparing SOA to past architecture, Web Services and Primitives: The web service framework, Service roles, Service models, Service descriptions, Messaging with SOAP, Planning and Analysis: SOA delivery lifecycle phases, The top down strategy, The bottom up strategy, The agile strategy, Service oriented analysis: Objectives and process of SOA, Service modelling and its guidelines, Classifying service model logic, Technology and Design: Service Oriented Design: Introduction to service oriented design, WSDL and related XML schema, SOAP language basics, Service interface design tools, SOA Composition: Steps to composing SOA, Choosing service layers, Considerations for positioning core SOA standards, Considerations for choosing SOA extensions, SOA Service design: Entity centric business service design, Task centric business service design, Application service design, Service design guidelines, Business process design: Service oriented business process design, SOA Platforms: Basics, SOA support in J2EE, SOA support in .net.

References:

1. Thomas Erl, Service Oriented Architecture (SOA): Concepts, Technology and Design, Pearson Education, 2016.
2. Eric Newcomer and Lomow, Understanding SOA with Web Services, Pearson Education, 2009.
3. Sandeep Chatterjee and James Webber, Developing Enterprise Web Services, Pearson Education, 2007.

HUM 5043 HUMAN RESOURCE MANAGEMENT [3 0 0 3]

HRM: HR and HRM, Role in organization, HR in Technical and Knowledge domain, Acquisition of HR, HR Planning, HRM vs. Personal Management, Development of HR, Motivation and Maintenance of HR Leadership: Technical Leadership, Leader's Goal, Conviction, Leader's Vision, Transformational and Transactional Leadership, Commitment and Professionalism, Importance of Professionalism, Manager's Role in Professionalism, Respect, Managing Technical and Professional people: Goals of Engineers and Scientists, Work Assignment and Need for Influence, Professional Career and Goals, Career Risks, Technical Competence, Training and Survival of Best fit, Performance and Motivation, Role of PMS evaluation, Professional Discipline, Manager's Role in Professional Discipline, Identification and Development of Talented people: Talented Professionals, Importance of Talent, Assessment and Recognizing Talent, Developing Technical Talent, Developing Managerial Talent, Development Needs, Planning and Counseling, Innovation: Importance of Innovation, Risk of Failure, Creativity from Imagination, Need of Creative Teams, Team environment and recognition: Team Dynamics, Innovative team Environment, Managing Innovative Teams, Manager's Responsibility in Innovation, Team's Personal Needs, Political versus Technical Solutions, Rewards and Recognition, Case studies in Indian Organizations.

References:

1. Jim Collins,Good to Great, Harper Collins Publishers, Volume 2, 2011.
2. Armstrong, Handbook of Human Resource Management Practice, Emerald Group Publishing limited, 2009.
3. K. Aswathappa, Human Resource and Personnel Management text and cases, Tata Mc-Graw Hill publishing Co. Ltd., 2002.
4. Wiseman and Grey, Multipliers How the Best leaders make everyone smarter, Harper Business Publishers, 2010.

MCA 5044 SOFTWARE PROJECT MANAGEMENT [3 0 0 3]

Managing Software Projects: Processes and Project Management, Process Planning: Case Study Example, Requirement Change Management: Change Management Process, Effort Estimation and Scheduling: Estimation and Scheduling Concepts, Effort Estimation: Bottom-up & Top-down Estimation, Use case Points, Effectiveness, Example, Scheduling: Overall, Effectiveness, Detailed, Quality Planning: Concepts, Quantitative Quality Management Planning, Example, Risk Management: Concepts, Assessment, Control, Example of Configuration Management, Measurement and Tracking Planning: Concepts, Measurements, The Project Management Plan: Process Database, Process Capability Baseline, Process Assets and Body of Knowledge System, The Project Management Plan, Team Management, Project Monitoring and Control: Tracking, Milestone Analysis, Defect Analysis and Prevention, Process Monitoring and Audit, Project Closure: Analysis, Report.

References:

1. Pankaj Jalote, Software Project Management in Practice, 1st Edition, Addison, Wesley, 2014.
2. Bob Hughes, Mike Cotterell, Rajib Mall, Software Project Management, 6th Edition McGraw Hill Education, 2017.
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, 8th Edition, McGraw Hill Publication, 2014.
4. Normal E Fenton, Shari Lawrence, Software Metrics, 5th Edition, Pfleeger Thompson, 2010.

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Biomedical Engineering
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Information Technology
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Media Technology

Post-Graduate Programmes Offered

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Computer Science and Engineering
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Environmental Engineering
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