School of Engineering and Technology

Department of
Mechanical and Automobile Engineering

Courses for

B.Tech- Robotics and Mechatronics

(Applicable For 2020-2021)

CHRIST (Deemed to be University) University, Bengaluru,

Karnataka, India

www.christuniversity.in

Syllabus for BTech- Robotics and mechatronics 2020-21 prepared by the Department of Mechanical and Automobile Engineering, School of Engineering and Technology and approved by the Academic Council, CHRIST {Deemed to be University}, Bangalore, India.

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1. INTRODUCTION

CHRIST {Deemed to be University} blossomed out of the educational vision of the Carmelites of Mary Immaculate {CMI} congregation founded by St Kuriakose Elias Chavara. He was a visionary, an educationist and a social reformer of the nineteenth century who founded the Congregation in 1831 in South India.

CHRIST {Deemed to be University} was established in July 1969 as Christ College. It was the first institution in Karnataka to be accredited by the National Assessment and Accreditation Council {NAAC}. University Grants Commission {UGC} conferred Autonomy to the institution in 2004. It became the first College in South India to be reaccredited with A+ by NAAC in 2005. UGC identified it as an Institution with Potential for Excellence in 2006.Under Section 3 of the UGC Act, 1956, Ministry of Human Resources Development of the Union Government of India, vide Notification No. F. 9-34/2007-U.3 {A}, declared Christ College as a Deemed to be University, in the name and style of CHRIST- Deemed to be University in July 2008. The University was accredited with 'A' Grade by NAAC in 2016.

CHRIST {Deemed to be University} offers 46 Bachelor, 47 Master, 16 MPhil and 17 PhD Programs in Humanities, Social Sciences, Sciences, Commerce and Management, Education, Law and Engineering. The University which celebrates diversity has students from all the states of India and 58 countries across the globe.

CHRIST {Deemed to be University} rooted in Gospel values, is committed to provide holistic education through the development of intellectual competence, personal skills, inter-personal skills and societal skills. The University welcomes to its fold students from all over the country and the world in an environment of religious harmony and secularism.

VISION

"EXCELLENCE AND SERVICE"

- CHRIST {Deemed to be University}, a premier educational institution, is an academic fraternity of individuals dedicated to the motto of excellence and service. We strive to reach out to the star of perfection through an earnest academic pursuit for excellence and our efforts blossom into 'service' through our creative and empathetic involvement in the society to transform it.
- Education prepares one to face the challenges of life by bringing out the best in him/her. If this is well accepted, education should be relevant to the needs of the time and address the problems of the day. Being inspired by Blessed Kuriakose Elias Chavara, the founder of Carmelites of Mary Immaculate and the pioneer in innovative education, CHRIST {Deemed to be University} was proactive to define and redefine its mission and strategies reading the signs of the time.

MISSION STATEMENT

"CHRIST {Deemed to be University} is a nurturing ground for an individual's holistic development to make effective contribution to the society in a dynamic environment."

CORE VALUES

The values which guide us at CHRIST {Deemed to be University} are:

Faith in God
Moral Uprightness
Love of Fellow Beings
Social Responsibility
Pursuit of Excellence

VISION OF DEPARTMENT

Develop Mechanical and Automobile engineering graduates to be successful in chosen professional career with innovative academic processes for the overall development.

MISSION STATEMENT

1. To provide excellent academic ambience in curricular co-curricular and extracurricular initiatives, facilities and teaching-learning experience.
2. To nurture holistic development of individuals.
3. To imbibe professional ethics driven by a sense of moral responsibility committed tothe service to society

PROGRAM EDUCATIONAL OBJECTIVES {PEO'S}:

PEO 1: Fundamental Knowledge Demonstrate fundamental knowledge in basic science and Mechanical Engineering, with critical and solution-oriented thinking for attaining professional excellence. **PEO 2: Industry Integration** Facilitate with industrial exposure within and outside the curriculum to integrate theoretical concepts with the latest industry practices.

PEO 3: Working in Team Exhibit professional competence towards real-time problem solving by cross–disciplinary understanding and effective team-building skills.

PEO 4: Social Responsibility Develop professionals with ethics, driven by a sense of social responsibility and service towards their peers, employers.

GRADUATE ATTRIBUTES:

1. Engineering Knowledge

2. Problem analysis

3. Design/development of solutions

4. Conduct investigations of complex problems

5. Modern tool usage

6. The Engineer and society

7. Environment and sustainability

8. Ethics

9. Individual and team work

10. Communication

11. Project management and finance

12. Life-long learning

PROGRAM OUTCOMES {PO'S}

At the end of graduation, the graduates of the Mechanical and Automobile Engineering Program are able to

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

2. PROGRAM OFFERED

- **Undergraduate Programmes** {B.Tech, 8 Semester Program }
    - Bachelor of Technology in Automobile Engineering {AE}
    - Bachelor of Technology in Civil Engineering{ CIVIL}
    - Bachelor of Technology in Computer Science and Engineering {CSE}
    - Bachelor of Technology in Electronics and Communication Engineering {ECE}
    - Bachelor of Technology in Electrical and Electronics Engineering {EEE}
    - Bachelor of Technology in Information Technology {IT}
    - Bachelor of Technology in Mechanical Engineering {ME}
    - Bachelor of Technology in Robotics and Mechatronics {RM}
        - Postgraduate Programmes {M. Tech, 4 Semester Program}
    - Master of Technology in Computer Science and Engineering {CSE}
    - Master of Technology in Communication Systems{ECE}
    - Master of Technology in Information Technology{IT}
    - Master of Technology in Machine Design{MD}
    - Master of Technology in Power Systems{PS}
    - Master of Technology in Structural Engineering{SE}
        - Doctoral Programmes {Ph.D.}{Doctor of Philosophy}
    - Doctor of Philosophy {Ph.D.} in Computer Science and Engineering
    - Doctor of Philosophy {Ph.D.} in Electronics and Communication Engineering
    - Doctor of Philosophy {Ph.D.} in Civil Engineering
    - Doctor of Philosophy {Ph.D.} in Electrical and Electronics Engineering

- Doctor of Philosophy {Ph.D.} in Mechanical Engineering
- Doctor of Philosophy {Ph.D.} in Information Technology

3. ELIGIBLITY CRITERIA

❖ **For Undergraduate Programmes**

A pass in PUC {10+2} or equivalent with 50% marks in aggregate with Mathematics, Physics and Chemistry is the minimum eligibility for admission.

Lateral Entry:

Candidates who have successfully completed 3 year diploma in Engineering are eligible to apply for lateral entry into:

- Automobile Engineering {AE}
- B.Tech Civil Engineering {CE}
- B.Tech Mechanical Engineering {ME}
- B.Tech Robotics and mechatronics {RM}
- B.Tech Computer Science and Engineering {CSE}
- B.Tech Electronics & Communication Engineering {ECE}
- B.Tech Electrical and Electronics Engineering {EEE}
- B.Tech Information Technology {IT}

Candidates will be admitted to second year of the programme only after appearing the Christ deemed to be University selection process for engineering programmes.

❖ **For Postgraduate Programmes**:

- For Master of Technology in Computer Science and Engineering
    - A Pass in B.Tech/B.E or M.Sc with 55% aggregate.
- For Master of Technology in Communication Systems
    - A Pass in B.Tech/B.E or M.Sc in Electronics and VLSI Design with 55% aggregate.
- For Master of Technology in Civil Engineering

- A Pass in BE/B.Tech or M.Sc in Civil and VLSI Design with 55% aggregate.

- For Master of Technology in Mechanical Engineering
  - A Pass in BE/B.Tech with 55% aggregate.

❖ **For Doctoral Programmes {Ph.D.}:**

- A pass with 55% marks in post-graduation and equivalent in the relevant subject from any recognized university.
- A research proposal {Maximum 1500 words} has to be submitted along with the application.

4. SELECTION PROCESS

1) Candidates can process the admission based on the Undergraduate Entrance Test and Ranking by COMEDK.

OR

2) Christ Selection Process as given below:

Process	Particulars	Date	Venue/Centre
Entrance Test	Christ Entrance test for each candidate	As per the E-Admit Card	As per the E- Admit Card
Personal Interview	Personal interview for 15 minutes for each candidate by an expert panel	As per the E-Admit Card	As per the E- Admit Card
Academic Performance	Assessment of past performance in Class 10, Class 11/12 during the Personal Interview	As per the E-Admit Card	As per the E- Admit Card

5. ADMISSION PROCESS

Candidates will be intimated about the Selection status {Selected/Wait Listed/Not Selected} through the University Notice Board/on the "Application Status" link on University website. The Selection results will be declared within 24 hours of Personal Interview session.

The selected candidates must process admission at **Office of Admissions, Central Block, Christ deemed to be University within 3 working days of declaration of Selection Process results/as per the stipulated date and time mentioned by Office of Admissions.**

Selected candidates should collect the Fee Challan from the Office of Admissions and remit the Annual fee at the South Indian Bank, CHRIST- Deemed to be University Branch. The Offer of Admission will stand cancelled, if failing to remit the fee within the stipulated date and time.

Admission will not be processed without the presence of the candidate and the mandatory original documents mentioned below;

1. The Offer of Admission Card {E-Admission Card/Mail}

2. Class 10 Marks Statement

3. Class 11 Marks Statement, if Candidate is pursuing class 12 and appearing for final examination during March-April Month

4. Class 12 Marks Statement, if candidate has appeared and passed the Class 12 examination

The University ID card is a smart card, which is both an ID card as well as a South Indian Bank ATM card with a chip containing the student personal details. All transactions within the University campus after commencement of classes, including fees payment will be processed only through this card. It is also an access card for Library and other restricted places. Candidates are advised to collect the South Indian Bank account opening form along with fees challan and process it at the Bank branch within the University premises.

Candidates who fall under International student category {ISC}, If selected, should register with the Foreigner Regional Registration Officer {FRRO/FRO} of the Local Police in Bangalore, India within 14 working days from the date of admission or arriving in Bangalore.

All International student category {ISC} candidates if studied in India should obtain an NOC from the previous qualifying institution.

6. GENERAL RULES

- There is a grading scheme for each paper and for all the courses.
- All marks will indicate the marks, percentage obtained, grade and grade point average.
- The grade point average will be calculated as follows: for each subject, multiply the grade point with the number of credits; divide the sum of product by the total number of credits.
- The CGPA [Cumulative GPA] is calculated by adding the total number of earned points [GP x Cr] for all semesters and dividing by the total number of credit hours for all semesters.

$$\mathbf{GPA} = \frac{\sum[\mathbf{GPA\ x\ Cr}]}{\sum \mathbf{Cr}}$$

7. GRADING SCHEME FOR EACH PAPER: Undergraduate Courses

Percentage	Grade	Grade Point	Interpretation	Class
80 and above	A	4.0	Outstanding	First Class with Distinction
73-79	A-	3.67	Excellent	First Class
66-72	B+	3.33	Very Good	
60-65	B	3.0	Good	
55-59	B-	2.67	Average	Second Class
50-54	C+	2.33	Satisfactory	
45-49	C	2.00	Pass	Pass Class
40-44	D	1.0	Pass	
39 and below	F	0	Fails	Fail

8. GRADING SCHEME FOR EACH PAPER: Postgraduate Courses

Percentage	Grade	Grade Point	Interpretation	Class
80 and above	A+	4.0	Excellent	First Class with Distinction
70-79	A	3.5	Very Good	
65-69	B+	3.0	Good	First Class
60-64	B	2.5	Above Average	
55-59	C+	2.0	Average	Second Class
50-54	C	1.5	Satisfactory	
40-49	C-	1.0	Exempted if aggregate is more than 50%	Pass Class
39 and below	F	0	Fails	Fail

We believe that the student opportunities and experiences should lead to an appreciation of the holistic development of individual. We also try to pass to our students our passion for what we do, and to have the students comprehend that we also desire to continue to learn.

9. PROGRAM OVERVIEW

The Mechanical Engineering Department has well established facilities for carrying out the activities of basic mechanical engineering. It is equipped to meet the present day technological advances and to meet the industrial requirements matching with the global standards. The department has the state of the art laboratories to meet the demand for practical knowledge by the present day industrial applications.

One of the oldest, largest and diversified of all engineering disciplines is mechanical engineering. Rated as one of the most "evergreen" branches, students of mechanical engineering can look forward to an exciting and robust study in the field of Thermal, Design, Materials and Manufacturing Engineering. A Holistic blend of both theory and practicals ensure that students are ready to face the challenges of the industrial world.

10. PROGRAM OBJECTIVE

The goal of our program is to prepare our graduates for successful professional practice and advanced studies by providing a broad education in mechanical engineering and by offering the opportunity to deepen their technical understanding in a particular concentration area of related technical electives. Following are the course objectives.

1. Join a technically sophisticated workforce as successful, practicing engineers in a wide range of mechanical engineering fields.
2. Continuously improve and expand their technical and professional skills through formal means as well as through informal self-study.
3. Pursue advanced degrees in engineering, business, or other professional fields.
4. Advance themselves professionally and personally by accepting responsibilities and pursuing leadership roles

11. TEACHING PEDAGOGY

- Team/Class room teaching.
- PowerPoint presentations and handouts.
- Simulated situations and role-plays.
- Video films on actual situations.
- Assignments.
- Case Studies.
- Exercises are solved hands on.
- Seminars
- Industry / Field visits.
- Information and Communication Technology.
- Project work.
- Learning Management System- Moodle

12. ASSESSMENT PATTERN - BTECH COURSE 2018 BATCH

Following are the details of the modifications proposed for assessment pattern - BTech course AY 2017-18

	Category	Weightage for CIA	Weightage for ESE
1	Courses with theory and practical	70	30
2	Courses with only theory	50	50
3	Courses with only Practical	50	50

COURSES WITH THEORY AND PRACTICAL				
	Component	**Assessed for**	**Minimum marks to pass**	**Maximum marks**
1	Theory CIA	30	-	30
2	Theory ESE	30	12	30
3	Practical CIA	35	14	35
4	Attendance	05	-	05
4	Aggregate	100	40	100

DETAIL OF MARK FOR COURSES WITH THOERY AND PRACTICAL										
THEORY						**PRACTICAL**				
	Component	**Assessed for**	**Scaled down to**	**Min. marks to pass**	**Max. marks**	**Component**	**Assessed for**	**Scaled down to**	**Min. marks**	**Max. marks**
1	CIA-1	20	**10**	-	**10**	Overall CIA	**50**	**35**	**14**	**35**
2	CIA-2	50	**10**	-	**10**					
3	CIA-3	20	**10**	-	**10**					
4	Attendance	05	**05**	-	**05**	Attendance	**NA**	**NA**	**-**	**-**
5	ESE	100	**30**	12	**30**	ESE	**NA**	**NA**	**-**	**-**
		TOTAL	**65**	-	**65**	TOTAL		**35**	**14**	**35**

- Minimum marks required to pass in practical component is 40%.

- Pass in practical component is eligibility criteria to attend Theory End semester examination for the same course.
- A minimum of 40 % required to pass in ESE -Theory component of a course.
- Overall 40 % aggregate marks in Theory & practical component, is required to pass a course.
- There is no minimum pass marks for the Theory - CIA component.
- Less than 40% in practical component is refereed as FAIL.
- Less than 40% in Theory ESE is declared as fail in the theory component.
- Students who failed in theory ESE have to attend only theory ESE to pass in the course

II. ASSESSMENT - ONLY FOR THEORY COURSE {without practical component}

- Continuous Internal Assessment {CIA} : 50% {50 marks out of 100 marks}
- End Semester Examination{ESE} : 50% {50 marks out of 100 marks}

Components of the CIA

CIA I : Subject Assignments / Online Tests	: 10 marks
CIA II : Mid Semester Examination {Theory}	: 25 marks
CIAIII: Quiz/Seminar/Case Studies/Project/Innovative Assignments/presentations/publications	: 10 marks
Attendance	: 05 marks
Total	**: 50 marks**

Mid Semester Examination {MSE} : Theory Papers:

- The MSE is conducted for 50 marks of 2 hours duration.
- Question paper pattern; Five out of Six questions have to be answered. Each question carries 10 marks

End Semester Examination {ESE}:

The ESE is conducted for 100 marks of 3 hours duration.

The syllabus for the theory papers are divided into FIVE units and each unit carries equal Weightage in terms of marks distribution.

Question paper pattern is as follows.
Two full questions with either or choice will be drawn from each unit. Each question carries 20 marks. There could be a maximum of three sub divisions in a question. The emphasis on the questions is to test the objectiveness, analytical skill and application skill of the concept, from a question bank which reviewed and updated every year.
The criteria for drawing the questions from the Question Bank are as follows
50 % - Medium Level questions
25 % - Simple level questions
25 % - Complex level questions

ASSESSMENT OF COMPREHENSION, INTERNSHIP and **SERVICE LEARNING**

Comprehension

Passing marks 40% min

Do not have ESE and completely evaluated through continuous assessment only,

The evaluation {minimum 2 presentations} shall be based on the

- Topic / report :40%
- Presentation: 40%
- Response to the questions asked during presentation: 20%.

Service Learning

Passing marks 40% min

Do not have ESE and completely evaluated through continuous assessment only,

Comprising

- Internal Assessment with components like tests/quiz/written assignments: 25 marks
- Field Work or equivalent assignment as approved by the department panel: 25 marks

Internship

Passing marks 40% min

Do not have ESE and completely evaluated through continuous assessment only

Continuous Internal Assessment is based upon

- No of Internship Days : 20 marks
- Type of Industry and Work Carried out : 10 marks
- Report on Internship : 10 marks
- Presentation on Internship : 10 marks

ASSESSMENT OF PROJECT WORK

Project work may be assigned to a single student {with due approval from department} or to a group of students not exceeding 4 per group.

Maximum Marks = 200

- Continuous Assessment 100 and the
- End Semester Examination {project report evaluation and viva-voce}: 100 marks.
- The continuous assessment and End Semester Examinations marks for Project Work and the Viva-Voce Examination will be distributed as indicated below.
- There shall be **3** review **and t**he student shall make presentation on the progress made before the committee constituted by the Department
- The total marks obtained in the 3 reviews shall be 100 marks.

CIA 100 MARKS	ESE 100 MARKS

Review 1		**Review 2**		**Review 3**		
REVIEW COMMITTEE	GUIDE	REVIEW COMMITTEE	GUIDE	REVIEW COMMITTEE	GUIDE	EXAMINERS
20	05	20	10	20	25	**100**
TOTAL	**25**	**TOTAL**	**30**	**TOTAL**	**45**	

ESE 100 MARKS IS EVALUATED AS

- Initial Write Up : 15 marks
- Viva Voce : 25 marks
- Demonstration : 35 marks
- Project Report : 25 marks

ASSESSMENT OF ENGINEERING GRAPHICS AND COMPUTER AIDED MACHINE DRAWING

- Continuous Internal Assessment {CIA} : 50% {50 marks out of 100 marks}
- End Semester Examination{ESE} : 50% {50 marks out of 100 marks}

Components of the CIA

CIA I : Assignments	: 10 marks
CIA II : Mid Semester Examination	: 25 marks
CIA III : Assignments	: 10 marks
Attendance	: 05 marks
Total	**: 50 marks**

End Semester Examination

3 hours duration for 100 marks

1. Engineering Graphics

- Projections of points, lines and plane surfaces –Manual Drawing : 30 marks
- Projections of Solids, Sections of solids - Computer Aided : 30 marks
- Development of surfaces and Isometric Projections - Computer Aided : 30 marks
- 3D modeling and assembly : 10 Marks

2. Computer Aided Machine Drawing

- Part-A –Manual Drawing : 20 marks
- Part-B - Manual Drawing : 20 marks
- Part-C - Computer Aided : 60 marks

13. Industry based Project for Final Year Students

Faculty of engineering brings the academics and tech community together to develop transformative ideas and develop pioneering and technologies for the digital age.

1. Scheme:

CHRIST {Deemed to be University} endeavours to instil the industry culture and to create job opportunities for its students. To facilitate this, the departments under faculty of engineering has taken the initiative to introduce 4-6 months industry based project intended for the final year UG students of the departments during their 8th semester. The scheme of 'industry based project' shall be option for the student to complete his/her course curriculum of 8th semester through 'experimental learning'.

S.no	Course Code	Course Name	Credit
1	XX831	Elective V	3
2	XX832	Elective VI	3
4	XX871	Project Stage-II	9
		Total	15

Note: "XX" refers to the subject code of the department respectively.

The scheme shall call for the mandatory core course {Elective I, II} of the semester to be completed before the commencement of the project tenure. The student shall follow all the norms of the deliverables under project work indicated in the curriculum.

The scheme shall be effective from the academic year 2017-18 as approved by the Interim Board of Studies of the Faculty of Engineering /Academic Council.

2. Eligibility Criteria:

For a student to be selected for this project, it is essential that he /she scores a minimum of 60% in every semester till the sixth semester of study without any repetition and/or backlog.

3. Selection Process:

a} Students interested to opt for the scheme must submit a written application addressed to the Head of the Department along with an official confirmation of Industry Project offer in the relevant area from any company chosen by the student within the specified time limit as may be announced by the Department. It shall be the responsibility of the student to identify the company which should be well established having fair credentials in the field of engineering.

b} Shortlisted students based on the above said criteria will be required to make a short presentation on their intended project to and will face a Viva-Voice by a select panel of faculty chosen by the Head of the Department. The following aspects will be considered while interviewing the student.

i. Relevance and duration of the project.

ii. Confidence/knowledge competence of the student in his/her presentation.

iii. Availability of monetary/non-monetary stipendiary benefits as per the offer letter issued by the Company for the Industry project.

iv. Company Credentials.

v. Inclination of the company to follow supervisory guidelines of the Faculty of Engineering.

vi. Opportunity for Placement.

c} The students selected by the Panel of Faculty alone will be permitted under the scheme to take up the Industry Based Project although the student would have obtained. The decision of the panel members taken in consultation with the Head of the Department will be final and binding.

d} Selected students must sign a letter of undertaking to abide by the rules specified.

4. Rules:

The following are the rules to be followed by a student who is selected for 6 months full time Industry Based Project:

i. The course content for the semester will be readjusted to include 70% of direct teaching hours and 30% of self-study modules.
ii. The CIA I and CIA 3 components for these courses should be completed before the commencement of the project as may be guided by the Faculty.
iii. The students who are selected are required to attend the centrally conducted Mid Semester Examination {CIA 2} and the End Semester Examination {ESE} by the University along with the other regular students without fail.
iv. For the selected students, the regular courses of eighth semester shall start immediately after the completion of the End Semester Examination {ESE} of seventh semester, and shall end before December of the particular Academic year.
v. There will be an Internal Faculty Guide as well as an External Company guide under whose guidance and supervision the student shall be required to undertake the project work.
vi. The student shall be bound by administrative rules and regulations of the company during the internship period and will attend to the company as per its working hours.
Vii. The student has to maintain a work record diary {a blue book} which needs to be updated daily with the work carried out by him/her at the selected company.
viii. The work diary needs to be got signed by the External Company Guide every day without fail.
ix. The work diary will be closely monitored by the Internal Guide and be reviewed every 15 days. The Internal Guide shall visit the working place of the student for such assessment.
x. Student performance will be graded independently by the two Guides and the combined grades of External and Internal Guides will be considered for the allotment of the CIA marks for the Project work.
xi. The students once selected into a company/industry project cannot withdraw from the project at any time of its duration for whatever reason. If such an event happen including for rejection by the company the student will be required to repeat the semester in the succeeding academic year in accordance with applicable University Regulations unless otherwise decided by the Disciplinary Committee.
xii. There shall be a Disciplinary Committee under the Head of the Department with 2 additional members nominated by the Associate Dean to deal with any of the following issues of indiscipline.
a. Non-compliance of the matters stated in the regulation by the student as may be reported by the either of the guides.
b. Irregular attendance by the student.
c. Withdrawal from the project work.
d. Any other matter as may be considered improper by the guides.
e. The committee may also directly take up disciplinary proceedings based on its own opinion.
The Decision of the committee as endorsed by the Associate Dean shall be final and binding on the student.

14. COURSE STRUCTURE

COURSE STRUCTURE OF I YEAR BTECH

I SEMESTER – CHEMISTRY CYCLE

Sl. No	Type	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	BSC	MA131	Mathematics – I	3	0	0	100	3	0	0	3
2	BSC	CH132P	Chemistry	3	0	2	100	3	0	1	4
3	ESC	EC133P	Basic Electronics	3	0	2	100	3	0	1	4
4	ESC	CS134P	Computer Programming	3	0	2	100	3	0	1	4
5	ESC	ME135	Basics of Mechanical Engineering and Nanoscience	3	0	0	100	3	0	0	3
6	HSMC	TE136P	Technical English	1	0	2	100	1	0	1	2
7	ESC	ME 151	Workshop Practice Lab	0	0	2	50	0	0	1	1
8	OE	HE171	Holistic Education-I	1	0	0	---	1	0	0	1
			Total				**650**				**22**

I SEMESTER – PHYSICS CYCLE

Sl. No	Type	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	BSC	MA131	Mathematics – I	3	0	0	100	3	0	0	3
2	BSC	PH132P	Physics	3	0	2	100	3	0	1	4
3	ESC	EE133P	Basic Electrical Engineering	3	0	2	100	3	0	1	4
4	ESC	CE134P	Basics of Civil Engineering & Engineering Mechanics	3	0	2	100	3	0	1	4
5	ESC	EG135P	Engineering Graphics	2	0	2	100	2	0	1	3
6	BSC	BS136	Bio Science	2	0	0	100	2	0	0	2
7	OE	HE171	Holistic Education-I	1	0	0	---	1	0	0	1
			Total				**600**				**21**

II SEMESTER – CHEMISTRY CYCLE

Sl. No	Type	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	BSC	MA231	Mathematics – II	3	0	0	100	3	0	0	3
2	BSC	CH232P	Chemistry	3	0	2	100	3	0	1	4
3	ESC	EC233P	Basic Electronics	3	0	2	100	3	0	1	4
4	ESC	CS234P	Computer Programming	3	0	2	100	3	0	1	4
5	ESC	ME235	Basics of Mechanical Engineering and Nanoscience	3	0	0	100	3	0	0	3
6	HSMC	TE236P	Technical English	1	0	2	100	1	0	1	2
7	ESC	ME 251	Workshop Practice Lab	0	0	2	50	0	0	1	1
8	OE	HE271	Holistic Education-II	1	0	0	---	1	0	0	1
			Total				**650**				**22**

II SEMESTER – PHYSICS CYCLE

Sl. No	Type	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	BSC	MA231	Mathematics – II	3	0	0	100	3	0	0	3
2	BSC	PH232P	Physics	3	0	2	100	3	0	1	4
3	ESC	EE233P	Basic Electrical Engineering	3	0	2	100	3	0	1	4
4	ESC	CE234P	Basics of Civil Engineering & Engineering Mechanics	3	0	2	100	3	0	1	4
5	ESC	EG235P	Engineering Graphics	2	0	2	100	2	0	1	3
6	BSC	BS 236	Bio Science	2	0	0	100	2	0	0	2
7	OE	HE271	Holistic Education-II	1	0	0	---	1	0	0	1
			Total				**600**				**21**

III SEMESTER

Sl. No	Type	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	BSC	MA331	Mathematics-III	3	0	0	100	3	0	0	3
2	PCC	RM332	Thermal Engineering	2	1	0	100	3	0	0	3
3	PCC	ME333P	Strength of Materials	3	0	2	100	3	0	1	4
4	PCC	RM334P	Analog and Digital Circuits	3	0	2	100	3	0	1	4
5	PCC	ME335P	Instrumentation & Control	3	0	2	100	3	0	1	4
6	OE	HE371	Holistic Education-III	1	0	0	---	1	0	0	1
7	BSC	BS351	Bio Science Laboratory	0	0	2	50	0	0	1	1
8	MC		Environmental Science	2	0	0	---	0	0	0	--
9											
			Total	17	1	8	550	16	0	4	**20**

IV SEMESTER

Sl. No	Type	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	PCC	RM431	Kinematics & Theory of Machines	3	0	0	100	3	0	0	3
2	PCC	RM432P	Microcontroller and Applications	3	0	2	100	3	0	1	4
3	PCC	ME433P	Fluid Mechanics & Fluid Machines	3	0	2	100	3	0	1	4
4	EEC	RM434	Manufacturing Process	3	0	2	50	3	0	2	2
5	HSMC	HS434	Professional Ethics	2	0	0	50	2	0	0	2
6	ESC	ME435	CAMD	2	0	2	100	2	0	1	3
7	OE	HE471	Holistic Education-IV	1	0	0	---	1	0	0	1
8	MC	MC	Cyber Security	2	0	0	---	0	0	0	--
9											
			Total	19	0	8	500	17	0	5	19

SEMESTER V

Sl. No	Type	Course No	Course Name	Hours			Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	PCC	M531P	Data Acquisition Systems	3	0	2	100	3	0	1	4
2	PCC	RM533	Design of Machine Elements	3	0	0	100	3	0	0	3
3	PEC	RM534E	Program Elective – 1	3	0	0	100	3	0	0	3
4	OE		Open Elective - I	2	0	0	50	2	0	0	2
5	OE		Open Elective - II	2	0	2	100	2	0	1	3
6	HSMC	HS536	Electrical Machines and drives	3	0	2	100	3	0	1	4
7	PCC	RM552	Analysis Lab	0	0	2	50	0	0	1	1
8	MC		Indian Constitution	2	0	0	---	0	0	0	0
			Total	18	0	8	600	16	0	4	20

SEMESTER VI

Sl. No	Type	Course No	Course Name	Hours			Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	PCC	RM631	CNC Technology	3	0	2	100	3	0	1	3
2	PCC	RM632P	Communication Systems	3	0	2	100	3	0	1	4
3	PCC	RM633P	Robotics and Vision System	3	0	0	100	3	0	0	3
4	PEC	RM634E	Fluid Power Automation	3	0	2	100	3	0	1	4
5	OE-Global		Open Elective - III	2	0	2	100	2	0	1	3
6	HSMC	HS637	Service Learning	0	0	4	50	0	0	2	2
			Total	14	0	12	550	14	0	6	19

SEMESTER VII

Sl. No	Type	Course No	Course Name	Hours			Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	PEC	RM731E	Program Elective – 2	3	0	0	100	3	0	0	3
2	PEC	RM732E	Program Elective – 3	3	0	0	100	3	0	0	3
3	PCC	RM751	Embedded System Lab	0	0	2	50	0	0	1	1
4	PCC	RM752	Computational Lab	0	0	2	50	0	0	1	1
5	OE		Open Elective – IV	2	0	2	100	2	0	1	3
6	**OE**		**Open Elective – V**	**3**	**0**	**0**	**50**	**3**	**0**	**0**	**3**
7	EEC-PROJ	RM771	Project Stage-I	2	0	2	100	2	0	1	3
8	EEC	RM772	Internship	0	0	4	50	0	0	2	2
			Total	13	0	12	600	13	0	6	19

SEMESTER VIII

Sl.No	Type	Course No	Course Name	Hours			Marks	Credits			Total Credits
				L	T	P		L	T	P	
1	PEC	RM831E	Program Elective – 4	3	0	0	100	3	0	0	3
2	PEC	RM832E	Program Elective – 5	3	0	0	100	3	0	0	3
3	EEC-PROJ	RM871	Project Stage-II	0	0	27	50	0	0	1	9
			Total	6	0	27	250	6	0	1	15

PROGRAMME ELECTIVE-1 (ME 534 E)										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	RM 534 E1	Automotive Engineering	3	0	0	100	3	0	0	3
2	RM 534 E2	Tribology and Bearing Design	3	0	0	100	3	0	0	3
3	RM 534 E3	Finite Element	3	0	0	100	3	0	0	3
4	RM 534 E4	Method Material Science and Technology	3	0	0	100	3	0	0	3
5	RM 534 E5	Data Structure	3	0	0	100	3	0	0	3

Program Elective- 2 (ME 731 E)										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	RM 731 E1	Python Programming	3	0	0	100	3	0	0	3
2	RM 732 E2	Data Communication Networking	3	0	0	100	3	0	0	3
3	RM 732 E3	Mobile Application Development	3	0	0	100	3	0	0	3
4	RM 732 E4	Sensors and Actuators	3	0	0	100	3	0	0	3
5	RM 732 E5	Wireless Sensor Networks	3	0	0	100	3	0	0	3

Program Elective-3 (ME 732E)										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	RM 732 E1	Rapid Prototyping	3	0	0	100	3	0	0	3
2	RM 732 E2	Machine Learning Using Python Programming	3	0	0	100	3	0	0	3
3	RM 732 E3	Artificial Intelligence for Mechatronics Systems	3	0	0	100	3	0	0	3
4	RM 732 E4	PLC and SCADA	3	0	0	100	3	0	0	3
5	RM 732 E5	Embedded Systems	3	0	0	100	3	0	0	3

Program Elective-4 (ME 831 E)										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	RM 831 E1	Operation Research	3	0	0	100	3	0	0	3
2	RM 831 E2	Product Design and Development	3	0	0	100	3	0	0	3
3	RM 831 E3	Industrial Engineering	3	0	0	100	3	0	0	3
4	RM 831 E4	Safety Engineering	3	0	0	100	3	0	0	3
5	RM 831 E5	System Modelling and Simulation	3	0	0	100	3	0	0	3

Program Elective-5 (ME 832 E)										
Sl. No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	RM 832 E1	IoT and Cyber Physical Systems	3	0	0	100	3	0	0	3
2	RM 832 E2	Biomedical Signal Processing	3	0	0	100	3	0	0	3
3	RM 832 E3	Hybrid-Electric Vehicles	3	0	0	100	3	0	0	3
4	RM 832 E4	Safety and Security of Automotive Systems	3	0	0	100	3	0	0	3
5	RM 832 E5	Power Electronics	3	0	0	100	3	0	0	3

OPEN ELECTIVES – I OFFERED BY THE DEPARTMENT										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	ME636OE01	Green Belt Practice	3	0	0	100	3	0	0	3
2	ME636OE02	Facility Planning and Design	3	0	0	100	3	0	0	3
3	ME636OE03	Basic Automobile Engineering	3	0	0	100	3	0	0	3
4	ME636OE04	Project Management	3	0	0	100	3	0	0	3
5	ME636OE05	Basic Aerospace Engineering	3	0	0	100	3	0	0	3
6	ME636OE06	Industrial Robotics	3	0	0	100	3	0	0	3
7	ME636OE07	Non Destructive Testing	3	0	0	100	3	0	0	3
8	ME636OE08	Energy and Environment	3	0	0	100	3	0	0	3
9	ME636OE09	Alternative Energy Sources for Automobiles	3	0	0	100	3	0	0	3
10	ME636OE10	Hybrid and Electric Vehicle	3	0	0	100	3	0	0	3

OPEN ELECTIVE – III GLOBAL ELECTIVES	
SL. NO	**COURSE NAME**
1	Dance course
2	Theatre direction
3	Theatre play
4	Voice improvement / vocal therapy
5	Digital writing
6	Digital Media
7	Intellectual property rights
8	Professional psychology
9	Organization Behavior
10	Corporate Social Responsibility
12	Creativity and Innovation
13	Languages - French
14	German
15	Asian Cuisine
16	Digital Marketing
17	Data Analytics Through SPSS
18	Selling With Emotional Intelligence
19	Learning Through Case Study

DETAILED SYLLABUS

SEMESTER I

COURSE NAME: MATHEMATICS I					
COURSE CODE :MA131					
	L	**T**	**P**	Category	**BSC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: This course is outlined to those who intend to apply the subject at the proper place and time, while keeping him/her aware to the needs of the society where he/she can lend his/her expert service, and also to those who can be useful to the community without even going through the formal process of drilling through rigorous treatment of Mathematics. At the end of this course, students will

- have a solid base of understanding elementary linear algebra as required for further undergraduate work in engineering.
- be able to differentiate a function partially with respect to each of its variables in turn
- be able to utilize methods of integration to compute length of arcs, surface area and volume of solids
- be skilled in using integration to compute problems important in physics and engineering
- learn the meaning and computation of the curl and divergence of a vector field.

  be able to solve first order differential equations that are separable, linear or exact

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Linear Algebra	
Fundamental concepts of Matrix, Rank of a Matrix, Consistency and solution of linear simultaneous equations, Eigen values and Eigen Vectors, Diagonalization	**5**
Unit-2:Differential Calculus I	
Partial Differentiation: Partial derivatives, Total differential coefficient, differentiation of composite and implicit functions, Jacobians and properties. Leibnitz's Rule of differentiation under integral sign.	**10**
Unit-3: Integral Calculus I	
Reduction formulae for the integration of $\sin^n x$, $\cos^n x$, $\sin^m x \cos^n x$ and evaluation of these integrals with standard limits - Problems. Derivative of arc length, Applications of integration to find surfaces of revolution and volumes of solids of revolution.	**10**
Unit-4:Differential Equation I	
Solution of first order and first degree differential equations: Reducible to Homogeneous, Linear and Exact differential equation, Applications of differential equations. orthogonal trajectories.	**10**
Unit-5: Vector Calculus I	

Vector differentiation. Velocity, Acceleration of a particle moving on a space curve. Vector point function. directional derivative, Gradient, Divergence, Curl, Laplacian. Solenoidal and Irrotational vectors - Problems. Standard vector identities.	**10**

Self-study : NIL

Site/Industrial Visits : NIL

Course outcomes:

CO1: Checking the consistency of system of linear equations and hence finding solution {L1} {PO1}
CO2: Finding the differentiation of multivariable functions using the concept of total derivatives, Jacobian, Evaluating definite integrals by Leibnitz rule of differentiation under integral sign {L1} {PO1}
CO3: Evaluation of definite integrals as surface area and volume of solid of revolution using reduction formulae {L3} {PO2}
CO4: Solving first order nonlinear differential equations by reducing into homogenous, linear and exact forms {L3} {PO2}
CO5: Finding the velocity and acceleration of a moving particle, vector potential, scalar potential {L1} {PO1}

Text Books:

T1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, July 2005.
T2. H. K. Das & Rajnish Verma, "Higher Engineering Mathematics", S. Chand & Company Ltd., 2011.

Reference Books:

R1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, Inc, 2005.
R2. Thomas and Finney, "Calculus", 9th Edition, Pearson Education, 2004.
R3. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Publication, Canada, 2007.
R4. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw – Hill, 2009.
R5. Michael Artin, "Algebra", 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2002.
R6. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2002.
R7. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006.
R8. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005.
R9. Sunita and Ratan Practical Engineering Chemistry, S.K. Kataria & Sons, 2013.

Online resources:

W1.http://nptel.ac.in

Course Name: Chemistry					
Course Code : CH 132P / CH 232P					
	L	**T**	**P**	Category	**BSC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives: This paper contains five units which are Chemical Energy Sources, Electrochemical Energy Systems, Corrosion Science, Surface Chemistry & Catalysis, Material Characterization Techniques and Water Technology.
This paper aims at enabling the students to know various energy sources, corrosion and its control, basics of surface chemistry, their application in catalysis, water technology and material characterization.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Techniques and Applications	
Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals). UV-Visible Spectroscopy – Principle - Types of electronic transitions - Energy level diagram of ethane and butadiene Instrumentation of UV-Visible spectrometer and applications. IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and -Determination of force constant of ditomic molecule (Numerical) –Applications.	**10**
Unit-2: Electrochemical Energy Systems	
Conductance, Ionic conductance, Transport number, Ionic mobility, activity coefficient and mean activity coefficients. Single electrode potential- origin, sign conventions. Derivation of Nernst equation. Standard electrode potential Construction of Galvanic cell–classification - primary, secondary and concentration cells, Concentration cell with and without transference, EMF of a cell, notation and conventions. Reference electrodes –calomel electrode, Ag/AgCl electrode. Measurement of single electrode potential. Numerical problems on electrode potential and EMF. Ion-selective electrode- glass electrode, Determination of pH using glass electrode.	**8**
Unit-3: Corrosion Science	
Corrosion - definition, Chemical corrosion and Electro-chemical theory of corrosion, Types of corrosion, Differential metal corrosion, Differential aeration corrosion (pitting and water line corrosion), Stress corrosion. Factors affecting the rate of corrosion, Corrosion control: Inorganic coatings – Anodizing and Phosphating, Metal coatings –Galvanization and Tinning, Corrosion Inhibitors, Cathodic and Anodic protection.	**9**
Unit-4: Surface chemistry & Catalysis	

Definition of thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties. First law of thermodynamics, internal energy, enthalpy, relation between internal energy & enthalpy, heat capacity, free energy. Second law of thermodynamics , Spontaneous & non spontaneous reactions, Gibbs-Helmholtz equation & related problems. Clausius-Clapeyron equation, Lavoisier & Laplace law, Exergonic & endergonic reactions in cells, Hess's law & its applications, van't Hoff isotherm, Equilibrium constant.	**11**
Unit-5: Material Characterization & Water Technology	
Theory and Applications of X-ray Photo electron Spectroscopy(XPS), Powder Xray diffraction (pXRD) **Water Technology:** Impurities in water,. Biochemical Oxygen Demand and Chemical Oxygen Demand. Numerical problems on BOD and COD. Sewage treatment. Purification of water- Desalination - Flash evaporation- Electro dialysis and Reverse Osmosis.	**7**
List of Experiments (If any):	**Practical Hours**
PART – A	
1. Determination of viscosity coefficient of a given liquid using Ostwald's viscometer.	**2**
2. Determination of copper by spectrophotometric method.	**2**
3. Conductometric estimation of an acid using standard NaOH solution	**2**
4. Determination of pKa value of a weak acid using pH meter.	**2**
5. Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution.	**2**
PART – B	
1. Determination of Total Hardness of a sample of water using disodium salt of EDTA.	**2**
2. Determination of percentage of Copper in brass using standard sodium thiosulphate solution.	**2**
3. Determination of Calcium Oxide (CaO) in the given sample of cement by Rapid EDTA method	**2**
4. Determination of Iron in the given sample of Haematite ore solution using potassium dichromate crystals by external indicator method.	**2**
5. Determination of Chemical Oxygen Demand (COD) of the given industrial waste Water sample.	**2**

Self-study : NIL

Site/Industrial Visits : NIL

Course outcomes:

CO1: Students will be able to distinguish between renewable and non-renewable energy sources. {L1} {PO1}

CO2: Students will gain an understanding of oxidation and reduction reactions which are relevant to study the concepts of corrosion science and electrochemistry. {L1} {PO1}

CO3: Students will be able to explain basics of physical and chemical phenomena taking place at solid surfaces. {L1} {PO1}

CO4: Students will be able to describe physiochemical techniques for material characterization. {L1} {PO1}

CO5: Students will be able to explain the fundamentals of water and waste water treatment. {L1} {PO1}

Text Books:

T1. Dr. B.S. Jai Prakash, "Chemistry for Engineering Students", Subhas Stores, Bangalore, Reprint 2015

T2. M. M. Uppal, "Engineering Chemistry", Khanna Publishers, Sixth Edition, 2002

T3. Jain and Jain, "A text Book of Engineering Chemistry", S. Chand & Company Ltd. New Delhi, 2009, Reprint- 2016

Reference Books:

R1. Atkins P.W. "Physical chemistry" ELBS 9 Edition 2009, London

R2. Stanley E. Manahan, "Environmental Chemistry", Lewis Publishers, Reprint 2009

R3. B. R. Puri, L. R. Sharma & M. S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Co., 33rd Ed., Reprint- 2016

R4. Kuriakose J.C. and Rajaram J. " Chemistry in Engineering and Technology" Vol I & II, Tata Mc Graw – Hill Publications Co Ltd, NewDelhi, First edition Reprint 2010

R5. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley - VCH.

R6. B. Viswanathan, S. Sivasanker , A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press, March 2002, Reprint 2011.

R7. D K Chakrabarthy, B. Viswanathan,"Heterogeneous Catalysis" New Age Internatioanl Publishers,2008.

R8. J. Bassett, R.C. Denny, G.H. Jeffery, "Vogels text book of quantitative inorganic analysis",5th Edition

R9. Sunita and Ratan Practical Engineering Chemistry, S.K. Kataria & Sons, 2013.

Online Resources:

W1.http//nptel.ac.in

Course Name: Basic Electronics					
Course Code : EC133P / EC233P					
	L	**T**	**P**	Category	ESC
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives: This course aims at imparting knowledge about electronic and digital systems, semiconductor theory and operational amplifiers. This course also includes a practical component which allows the students to recognize the different elements used in electronics and digital systems.

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1: Basic Semiconductor And P-n Junction Theory	
Atomic Theory – Atom, Electron Orbits and Energy Levels - Conduction in solids – Electron Motion and Hole Transfer, Conventional Current and Electron Flow – Conductors, Insulators and Semiconductors – Energy Band Diagrams – Variation of band gap with temperature. Intrinsic and Extrinsic Semiconductors – Doping, n type and p type material, Majority and minority carriers, Charge Carrier Density, Mass Action Law. Semiconductor Conductivity – Drift Current, Diffusion Current, Charge Carrier Velocity, Condyctivity.The pn Junction – Biased Junctions – Junction Currents and Voltages.VI Characteristics – Static and Dynamic Resistance.Zener diode characteristics, Zener and Avalanche breakdown**.**	**9**
Unit-2: Diode Applications	
Diode Approximations – DC Load Line Analysis - DC voltage applied to diodes (Si and zener diodes only). (Simple analysis using KCL and KVL). Rectifiers – Half Wave rectifier – Full Wave Rectifier – Bridge Rectifier : dc load current and voltage, rms load current and voltage, ripple factor, efficiency, PIV. Simple Capacitor Filter(Analysis not expected) – Simple Shunt Zener Voltage Regulator	**9**
Unit-3: Bipolar Junction Transistor	
Bipolar Junction Transistors: Transistor Construction – Operation – Common Base Configuration – Transistor Amplifying action – Common Collector – Common Emitter. Transistor currents. Common emitter current gain – Common Base Current gain – Relationship. Transistor Biasing : Operating Point – Significance – Fixed Bias and Voltage Divider Bias – Simple analysis.	**9**
Unit-4: Introduction To Operational Amplifiers	

Block diagram, Op-amp transfer characteristics, Basic Op-amp parameters and its value for IC 741- offset voltage and current, input and output impedance, Gain, slew rate, bandwidth, CMRR, Concept of negative feedback, Inverting and Non-inverting amplifiers, Summing Amplifier, Subtractor, Differential Amplifier, integrator, differentiator, Voltage follower, Introduction to Oscillators, the Barkhausen Criterion for Oscillations, Applications of Oscillator	**9**
Unit-5: Digital Electronics	
Sampling theorem, Introduction, decimal system, Binary, Octal and Hexadecimal number systems, addition and subtraction, fractional number, Binary Coded Decimal numbers. Boolean algebra, Logic gates, Two Variable and three variable K – maps - Half-adder, Full-adder, Logic Design based on two and three input variables only.	**9**
List of Experiments (If any):	**Practical Hours**
1. Use of basic voltage source and measuring instruments (Power supply, function generator, DSO, Digital Multimeter), familiarization of breadboard.Measurement of Voltage and Frequency using DSO	**2**
2. Study of step down transformer. Measuring the secondary voltage waveform on DSO and determination of peak and rms value	**2**
3. Identification and testing of electrical/electronic active and passive components	**2**
4. Color coding of resistors and capacitor coding	**2**
5. Study of Series and Parallel circuits to verify Kirchoff's Voltage Law and Current Law – using breadboard, DMM and DC power supply.	**4**
6. Half Wave Rectifier and Full Wave Rectifier : study of waveforms, determination of DC value of rectified wave	**4**
7. Study of different types of logic gates – NOT, OR, AND, NAND, NOR and Ex-OR	**4**
8. Verification of output of a logical expression using Basic gates/NAND gates/NOR gates	**2**
9. Soldering and de-soldering of electronic components on PCB	**2**
10. Determination of forward and reverse bias characteristics of silicon diode	**4**
11. Application of Zener diode as a basic voltage regulator	**2**
Self-study : NIL	
Site/Industrial Visits : NIL	
Course outcomes: At the end of the course, the student will be able to : CO1: Describe the basic semiconductor principles , working of p-n junction diode and transistors [L2] [PO1] CO2: Demonstrate the operation of diodes in rectifiers, voltage regulator and clipper [L3] [PO1] CO3: Explain the operation of bipolar junction transistor including the amplification and biasing [L2] [PO1, PO6] CO4: Explain the operation and applications of Operational Amplifier [L2] [PO1]	

CO5: Discuss conversions between binary, decimal, octal and hexadecimal number system [L2] [PO1]
CO6: Implement digital logic gates and its application as adders. [L3] [PO1, PO6]

Text Books:

T1. David A. Bell, "Electronic Devices and Circuits" – Vth Edition, OUP, 2011
T2. N. P. Deshpande, "Electronic Devices and Circuits – Principles and Applications", TMH, 2017
T3. Robert L Boylestad& Louis Nashelsky, "Electronic Devices and Circuit Theory", 3rd Edition, 2015
T4. Morris Mano, "Digital Logic and Computer Design", PHI, EEE, 2014

Reference Books:

R1. Donald A. Neamen, "Electronic Circuits", 3rd Edition, TMH, 2017
R2. Thomas L. Floyd, "Electronic Devices", Seventh Edition, Pearson Education, 2012
R3. Albert Malvino, David. J. Bates, —Electronic Principle, 8th Edition, Tata McGraw Hill, 2015

Online Resources:

W1. http//nptel.ac.in

Course Name: Computer Programming					
Course Code : CS134P / CS234P					
	L	**T**	**P**	Category	**ESC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

- To provide exposure to problem-solving through programming.
- To provide a basic exposition to the goals of programming
- To enable the student to apply these concepts in applications which involve perception, reasoning and learning.

Units	**Teaching Hours**
Unit-1 Algorithms And Flowcharts, Constants, Variables And Datatypes, Operators, Managing Input And Output Operations	
Algorithms and flowcharts: Algorithms, Flowcharts, Examples on algorithms and flowcharts. Basic structure of a C program, C Tokens, Data types. Declaration of variables. Operators: Arithmetic operators, Relational operators, Logical operators, Assignment operators, Increment and Decrement operators, Conditional operator, Bitwise operators, Special operators, Arithmetic expressions, Evaluation of expressions, Precedence of Arithmetic operators, Type conversions in expressions, Operator precedence and associatively. Managing input and output operations: Reading a character, writing a character, Formatted Input, Formatted Output.	**9**
Unit-2: Decision Making And Branching, Looping	
Decision making and branching: Decision making with if statement, Simple if statement, The if…else statement, Nesting of if…else statements, The else … if ladder, The switch statement, The ?: operator, The Goto statement Looping: The while statement, The do statement, The for statement, Jumps in Loops	**9**
Unit-3: Arrays, User Defined Functions	
Arrays: One-dimensional Arrays, Declaration of one-dimensional Arrays, Initialization of one-dimensional Arrays, Two-dimensional Arrays, Initializing two-dimensional Arrays. User-defined functions: Need for User-defined Functions, A multi-function Program, Elements of user - defined Functions, Definition of Functions, Return Values and their types, Function Calls, Function Declaration, Category of Functions, No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Value, recursion –recursive functions, Limitations of recursion.	**9**
Unit-4: Pointers	

Understanding the pointers, Accessing the Address of a Variable, Declaring Pointer Variables, Initialization of Pointer Variables, Accessing a Variable through its Pointer, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and Arrays, Pointers and Character Strings, Pointers as Function Arguments.	**9**
Unit-5: Strings, Derived Types, Files	
Strings: String concepts: declaration and initialization, String I/O functions, Array of strings, String manipulation function, Structure: Basic of structures, structures and Functions, Arrays of structures, structure Data types, type definition. Files: Defining, opening and closing of files, Input and output operations, Standard Library Functions for Files	**9**
List of Experiments :	**Practical Hours**
1. To understand and realize the use of C tokens, Keywords and Identifiers, Variables, Data types, Declaration of variables, using operators, I/O functions.	**4**
2. To understand and implement concepts of Decision making statements.	**4**
3. To understand and implement concepts looping statements.	**6**
4. To understand and implement concepts of Arrays.	**4**
5. To understand and implement concepts of Pointers	**4**
6. To understand and implement concepts of User defined functions.	**4**
7. To understand and implement concepts of Strings and Structures.	**4**
Self-study: NA	
Site/Industrial Visits: NA	
Course outcomes: CO1: Solve problems using flowchart and algorithm. (Applying, PO1, PO3) CO2: Exhibit the concept of looping and decision-making statements to solve problems. (Applying, PO1, PO3) CO3: Demonstrate different Operations on arrays and user defined functions. (Applying, PO1, PO3) CO4: Illustrate the appropriate use of pointers. (Applying, PO1, PO3) CO5: Illustrate the appropriate use of strings, files, structures to solve real time problems. (Applying, PO1, PO3)	
Text Books: T1. Deitel and Deitel, "C How to Program", Prentice Hall 2010 (Reprint). T2. Herbert Schildt, "C++ : The Complete Reference", McGraw - Hill Osborne Media; 3rd edition 2012 (Reprint). T3. YashvantKanetkar, "Let Us C 13E", BPB Publications – 13th Edition, 2013.	
Reference Books: R1. Shelly and Junt, "Computers and Commonsense", 4th edition, Prentice Hall of India, 2010 (Reprint). R2. Dennis P. Curtin, Kim Foley, Kunal Sen, Cathleen Morin, "Information Technology: The Breaking wave", Tata MC GrawHill Companies, 2010 (Reprint).	

R3. Peter Norton, "Introduction to Computers", 2011 (Reprint).
Online Resources: W1.V. K. Myalapalli, J. K. Myalapalli and P. R. Savarapu, "High performance C programming," 2015 International Conference on Pervasive Computing (ICPC), Pune, 2015, pp. 1-6 W2. https://users.ece.cmu.edu/~eno/coding/CCodingStandard.html W3. https://www.w3resource.com/c-programming-exercises/

Course Name: Basics of Mechanical Engineering and Nanoscience					
Course Code : ME 135 / ME 235					
	L	**T**	**P**	Category	**ESC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

1. To elucidate and critically demonstrate the Energy sources and basic thermodynamic concepts behind energy transfer.
2. To distinguish and elaborate the different types of prime movers.
3. To describe the functioning of refrigeration and air-conditioning.
4. To evaluate and apply the concepts of nano-science in real engineering applications.
5. To demonstrate and apply the process of machining and metal joining in basic applications.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Energy Resources, Thermodynamics and Heat transfer	
Energy Resources Conventional Energy resources- Fossil fuel and nuclear fuel, Merits and demerits. Non-conventional energy sources- Solar, Wind, hydraulic, Ocean-thermal, Geo-thermal, Tidal energy and bio mass energy plants working principle. **Thermodynamics** Basic terms: State, path, process (reversible and irreversible), and cycle, System, surroundings and boundary. Closed system, Open system and Isolated Systems. Laws of Thermodynamics (statements and brief description). Heat engine and Heat pump (Definition). **Heat Transfer** Modes of Heat transfer and their basic governing equations. Heat exchangers-types. Fins – types and applications.	**12**
Unit-2: I.C. Engine and Turbines	
I.C. Engines Classification, I.C. Engines parts and their function, working of 2 Stroke and 4 stroke engines. Basic terms - Indicated power, brake power frictional power, thermal efficiency, mechanical efficiency (simple problems). **Steam Generators** Boilers, fire and water tube boilers (Lancashire and Babcock and Will Cox boiler-working with simple sketches)**.** **Steam turbines** Classifications, Principle of operation of Impulse and reaction turbines. **Gas Turbines** Open cycle and closed cycle gas turbines working principle. **Water Turbines** Classification, working principle of Pelton wheel, Francis turbine and Kaplan turbine**.**	**10**

Unit-3 Refrigeration and Air-conditioning	
Refrigeration Types of refrigerants and properties of good refrigerant, Refrigerating effect and unit of Refrigeration (definition). Working principle of vapour Compression refrigeration and vapour absorption refrigeration (with sketch). Applications areas of refrigeration system. **Air Conditioning** Definition, types, Room air-conditioning working principle (with sketch), Applications.	**6**
Unit-4 Introduction to Nanotechnology	
Introduction to Nanotechnology Introduction to about Nanomaterials, characterization of nanomaterials-SEM, XRD, AFM and Mechanical properties, Advantages, limitations and applications of Nanomaterials.	**7**
Unit-5 Machine tools and Metal joining processes	
Machine tools Lathe Machine-Types, Parts and different operations like-turning, facing, grooving, parting off, taper turning, and threading (simple sketch) Drilling Machine-Types, Parts and different operations like-drilling, reaming, boring, counter boring, counter sinking and tapping (simple sketch). Milling Machine-Up milling, down milling, Plane milling, End milling, Slot milling and gear cutting (sketches only for following operations) **Metal joining** Definitions, classification of soldering, Brazing and welding. Differences between soldering, brazing and Welding. Description of Electric Arc welding and Oxy-Acetylene gas welding (Simple sketch).	**10**
Self-study: Unit-1: Distillation process of crude oil, Harnessing of Ocean-thermal Energy. Unit-2: 4 Stroke Diesel Engine, 2 Stroke petrol engine, Water turbines. Unit-3: Office air-conditioning systems. Unit-4: TEM, UTM techniques for characterization of Nanomaterials. Unit-5: Trepanning operation, Vertical milling machine, brazing and soldering applications.	
Site/Industrial Visits: 1. Heat Transfer Lab. 2. Fluid mechanics and Machinery Lab. 3. Metal Cutting Lab. 4. I.C. Engine Lab.	
Course outcomes: The students will be able to CO1: Classify the energy resources and state the basic laws of the thermodynamics and illustrate with an example modes of heat transfer. [L1, L2] [PO1, PO2]. CO2: List the types of I.C. Engines and turbines, discuss the working principle of I.C. engines and turbines. [L1, L3] [PO1, PO2, PO3]. CO3: Define the terms refrigeration and air-conditioning, identify their application areas. [L1, L2, L3] [PO1, PO2, PO3].	

CO4: Explain the fundamental concept of nanotechnology and describe the characterization methods for nanomaterials. [L1, L2] [PO1, PO2].
CO5: Summarize the operations performed by using machine tools and distinguish between welding soldering and brazing process. [L1, L2, L4] [PO1, PO2, PO3, PO4].

Text Books:

T1. K.R. Gopalkrishna, "A text Book of Elements of Mechanical Engineering", Subhash Publishers, Bangalore, 2008.
T2. S. Trymbaka Murthy, "A Text Book of Elements of Mechanical Engineering", 3rd revised edition, I .K. International Publishing House Pvt. Ltd., New Delhi. 2010.
T3. P.K.Nag, "Engineering Thermodynamics" Tata McGraw-Hill Education, 2005.
T4. B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, "Nano Science and Nano Technology ", University Press IIM, 2002.

Reference Books:

R1. Dr. R. P. Reddy, "Elements of Mechanical Engineering", 1st Edition, Himalaya Publishing House, New Delhi, 2012.
R2. Hajra Choudhury S K, "Elements of Workshop Technology" 13th Edition, Volume 1, Machine Tools, India Book Distributing Company Calcutta, 2010.
R3. Hajra Choudhury S K, "Elements of Workshop Technology" 13th Edition, Volume 2, Machine Tools, India Book Distributing Company Calcutta, 2012.
R4. Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", Wiley India Edition, 2012.

Online Resources:

W1. http://www.hds.bme.hu/letoltesek/targyak/BMEGEVGAG01_ENG/ime.pdf
W2. http://www.nptel.ac.in/downloads/112108148.

Course Name: Technical English					
Course Code : TE 136P / TE 236P					
	L	**T**	**P**	Category	**HSMC**
Contact Hrs./Week	**1**	**0**	**2**	CIA Marks	**25**
Contact Hrs./Sem.	**15**	**0**	**30**	ESE Marks	**25**
Credits.	**1**	**0**	**1**	Exam Hours	**2**

Course objectives: Upon Successful completion of this course, the student will have reliably demonstrated the ability to respond effectively, efficiently, and appropriately to writing in ways that demonstrate comprehension and evaluation of its purpose and meaning.

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1: Vocabulary Building	
Concept of word formation, synonyms , antonyms, homophones, prefixes and suffixes, Misused and confused words.	**8**
Unit-2: Basic Writing Skills	
Sentence structure, parts of speech, Fragments, Run-on errors, Phrases and clauses, Misplaced and Dangling modifiers, Structure of paragraphs Techniques of writing precisely.	**8**
Unit-3: Identifying Common Errors In Writing	
Subject verb agreement(concord), articles, prepositions, Tenses, Redundancies, cliché's , Misused and confused words	**9**
Unit-4: Essay Writing (Lang. Lab)	
ESSAY WRITING (Lang. Lab), Structure of an Academic essay, writing introduction , thesis statement, writing body paragraphs , writing concluding paragraph, unity, support, coherence and sentence skills , Different types of essay.	**10**
Unit-5: Oral Communication	
(Interactive practical sessions in lang. lab), listening comprehensions, pronunciation, intonation, stress and rhythm, interview and formal presentation skills.	**10**
Self-study: NA	
Site/Industrial Visits: NA	

Course outcomes:

At the end of the course, the student will be able to :

CO1: Acquire basic proficiency in all the English language skills: reading , listening comprehension, writing ,and speaking {L2} {PO1}

CO2: Have a better understanding of the Mechanics of English language {L2} {PO1}

CO3:Make an organized, and well prepared oral presentation to meet the needs of individuals and small groups. {L2} {PO1}

CO4: Write good academic essays {L2} {PO1}

CO5: Take part in group discussions with a better speaking skill. {L2} {PO1,PO9,PO10}

Text Books:

T1. Practical English Usage. Michael Swan. OUP. 1995

T2. Remedial English Grammar. F.T. Wood. Macmillan.2007

Reference Books:

R1 On Writing Well. William Zinsser. Harper Resource Book. 2001

R2. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

R3. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

R4. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Online Resources:

W1. http://www.nptel.ac.in/

Course Name: Workshop Practice					
Course Code : ME 151 / ME 251					
	L	**T**	**P**	Category	**ESC**
Contact Hrs./Week	**0**	**0**	**2**	CIA Marks	**25**
Contact Hrs./Sem.	**0**	**0**	**30**	ESE Marks	**25**
Credits.	**0**	**0**	**1**	Exam Hours	**2**

Course objectives: To provide the students with the hands on experience on different trades of engineering like fitting, welding, carpentary & sheet metal.

Units	**Teaching Hours**
List of Experiments (If any):	**Practical Hours**
1. Safety Precautions and description of workshop tools and equipments.	1
2. Study of fitting tools and equipments.	2
3. Demonstrate and make a square fitting model.	4
4. Demonstrate and make a V fitting model.	2
5. Demonstrate and make a dovetail fitting model.	4
6. Study of electric arc welding tools and equipments.	1
7. Demonstrate and make a Butt Joint welding model.	2
8. Demonstrate and make a Lap Joint welding model.	2
9. Demonstrate and make a T-Joint welding model.	2
10. Demonstrate and make a L-Joint welding model.	2
11. Study of sheet metal tools and equipments.	1
12. Demonstrate and make a rectangular tray.	2
13. Study and demonstration of Carpentry tools, joints and operations.	1
14. Study and demonstration of MIG welding.	2
15. Study and demonstration of TIG welding.	2

Self-study: NA

Site/Industrial Visits: NA

Course outcomes:

CO1: Demonstrate an understanding of and comply with workshop safety regulations. {L1,L2} {PO1,PO2, PO7, PO10}

CO2: Select and perform a range of machining operations to produce a given project.{ L1,L2,L3} {PO1,PO6,PO7,PO9,PO10}

CO3: Identify and use marking out tools, handtools, measuring equipment and to work to prescribed tolerances. { L1,L2,L3} {PO1,PO2,PO6,PO9,PO10}

CO4: Demonstrate a knowledge of welding process selection and capabilities. { L2,L3} {PO1,PO2,PO7,PO9,PO10}

CO5: Demonstrate a knowledge of welding, joint design and the application of welding. { L2,L3,L4} {PO1,PO2,PO6,PO7,PO9,PO10}

Text Books:

T1. S. K. H. Choudhury, A. K. H. Choudhury, Nirjhar Roy, "The Elements of Workshop Technology", Vol 1 & 2, Media Propoters and Publishers, Mumbai, 2018.

Reference Books:

R1. P. Kannaiah and K.L. Narayana, "Manual on Workshop Practice", Scitech Publications, (1999).

R2. T Jeyapoovan, "Engineering Practices Lab - Basic Workshop Practice Manual,"
ISBN: 81-259-1800-0

R3. H.S.Bawa, "Workshop Practice", Tata McGraw Hill Publishing Company Limited, (2007)

Online Resources:

W1. https://nptel.ac.in/noc/

W2. http://ecoursesonline.iasri.res.in

SEMESTER II

Course Name: Mathematics II					
Course Code : MA 231					
	L	**T**	**P**	Category	**BSC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: Mathematics is a necessary avenue to scientific knowledge which opens new vistas of mental activity. A sound knowledge of engineering Mathematics is a 'sine qua non' for the modern engineer to attain new heights in all aspects of engineering practice. This course provides the student with plentiful opportunities to work with and apply the concepts, and to build skills and experience in mathematical reasoning and engineering problem solving.At the end of this course, the students will

- be introduced to the tools of integration of multivariate functions over areas and volumes.
- learn the technique of multidimensional change of variables to transform the coordinates over which integration proceeds by utilizing Jacobian. Specifically, students will learn how to transformbetween an integral over an area or volume in Cartesian coordinates to polar coordinates.
- be able to solve higher order homogenous/ non-homogenous linear differential equations with constant coefficients
- be able to solve Cauchy's and Legendre's equations.
- learn the fundamental vector calculus integral theorems of Green, Stokes' and Divergence. Students will also learn how these theorems represent conservation principles for physical vector fields important in gravitation and electric fields.
- be able to perform operations with Laplace and inverse Laplace transforms to solve higher order differential equations

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Differential Calculus – II	
Polar curves and angle between Polar curves. Pedal equations of polar curves, Radius of curvature – Cartesian, parametric, polar and pedal forms.	**8**
Unit-2: Integral Calculus – II	
Double integrals, Cartesian and polar co – ordinates, change of order of integration, change of variables between cartesian and polar co – ordinates, triple integration, area as a double integral, volume as a triple integral.	**14**
Unit-3: Differential Equations – II	
Linear differential equations of second and higher order with constant coefficients. Method of variation of parameters. Legendre'a and Cauchy's homogeneous differential equations.	**10**
Unit-4: Laplace Transforms	

Definition – Transforms of elementary functions – Properties, Derivatives and integrals of transforms- Problems. Periodic function. Unit step function and unit impulse function, Inverse transforms, Solutions of linear differential equations.	**10**
Unit-5: Vector Calculus – II	
Vector Integration – Green's theorem in a plane, Gauss's divergence theorems, Stoke's, (without proof) and simple application.	**7**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: CO1: Find the angle between the polar curves and radius of curvature by applying differentiation {L1} {PO1} CO2: Calculate the area and volume of solids using double and triple integration. {L2} {PO2} CO3: Solve linear differential equations of higher order by using inverse differential operator, Method of undetermined coefficients and variation of parameters. {L3} {PO2} CO4: Solve initial value problems using Laplace Transforms method {L3} {PO2} CO5: Establish the relation between the line and surface integral, surface and volume integral using Green's, Stoke's and Gauss Divergence theorem {L2} {PO2}	
Text Books: T1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, July 2005. T2. H. K. Das & Rajnish Verma, "Higher Engineering Mathematics", S. Chand & Company Ltd., 2011.	
Reference Books: R1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, Inc, 2005 R2. Thomas and Finney, "Calculus", 9th Edition, Pearson Education, 2004 R3. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Publication, Canada, 2007 R4. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw – Hill, 2009. R5. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006. R6. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005. R7. Paras Ram, "Engineering Mathematics through Applications", 1st Edition, CBS Publisher, 2011.	
Online Resources: W1. https://nptel.ac.in	

Course Name: Physics					
Course Code : PH132P / PH232P					
	L	**T**	**P**	Category	**BSC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**15**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3 hrs**

Course objectives: This paper contains five UNITS which are Modern Physics, Quantum Mechanics, Conductivity in Metals (Electrical and Thermal), Elastic, Dielectric and Optical Properties of Materials, Lasers, Optical Fibers.

At the end of the course, the students would be able to

- Identify the fundamental aspects of modern physics and quantum mechanics.
- Compare classical and quantum free electron theory.
- Outline the salient properties of elastic and dielectric materials.
- Apply the concepts learnt in Laser, Fiber optics in the field of Engineering.
- Apply optical phenomenon in technology.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Modern Physics	
Introduction, Planck's theory - Deduction of Wien's displacement law and Rayleigh Jean's law from Planck's law, Compton effect, de Broglie hypothesis – extension to electron particle. Phase velocity, group velocity, expression for group velocity based on superposition of waves, relation between group velocity and particle velocity. Problems.	**9**
Unit-2: Quantum Mechanics	
Heisenberg's uncertainty principle and its physical significance. Application of uncertainty principle (Non-existence of electron in the nucleus). Wave function. Properties and Physical significance of a wave function Schrodinger - Time independent wave equation – Application: Setting up of a one dimensional Schrödinger wave equation of a particle in a potential well of infinite depth : Probability density and Normalization of wave function – Energy Eigen values and Eigen function. Problems.	**9**
Unit-3: Electrical and Thermal Conductivities of metals	
Classical free-electron theory. Introduction, assumptions and limitation of classical free-electron theory. Thermal Conductivity. Wiedemann - Franz law, calculation of Lorentz number. **Quantum free-electron theory –** Postulates of quantum fee electron theory, Fermi - Dirac Statistics. Fermi-energy – Fermi factor. Density of states. Carrier concentration in metals. Expression for electrical resistivity/conductivity - Merits of Quantum free electron theory. Problems.	**10**
Unit-4: Materials Science	

Elasticity : Introduction - Bending of beams – Single Cantilever – Application of Cantilever in AFM, Young's modulus-Non uniform bending. Problems. **Dielectrics :** Dielectric constant and polarisation of dielectric materials. Types of polarisation. Equation for internal fields in liquids and solids (one dimensional). Clausius – Mossotti equation. Ferro and Piezo – electricity(qualitative). Frequency dependence of dielectric constant. Important applications of dielectric materials. Problems.	**9**
Unit-5: Applied Optics	
Lasers: Principle and production. Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for Laser action. Principle, Construction and working of He-Ne and semiconductor diode Laser. Applications of Laser – Laser welding, cutting and drilling. Measurement of atmospheric pollutants. Problems. **Optical Fibers:** Introduction, Principle andPropagation of light in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Applications –optical fiber communication system. Problems.	**8**
List of Experiments (If any):	**Practical Hours**
PART – A	
1. Basic Measuring Instruments • Vernier Callipers • Screw Gauge • Travelling Microscope	**02**
2. Verification of Stefan's law	**01**
3. Planck's Constant (Determination of Planck's constant using LED or using the principle of photoelectric effect)	**01**
4. Determination of Fermi energy.	**01**
5. Young's modulus – Non-uniform bending.	**01**
6. Measurement of Dielectric Constant (Charging & discharging of capacitor).	**02**
7. Ultrasonic Interferometer.	**01**
8. Interference at a wedge.	**02**
9. Laser Diffraction (Determination of grating constant and number of rulings per inch using diffraction grating).	**01**
10. Frequency determination – Melde's apparatus	**02**
11. Photo Multiplier Tube – Demonstration only	**01**

Course outcomes:

1. To outline the principles of Classical Physics and Modern Physics.
2. To classify the materials according to the theories of Quantum Physics.
3. To apply the principles of Physics to solve the problems in different relevant topics.
4. To analyze different materials for various scientific applications.
5. To apply the principles of optics in the field of LASERS and Optical Fiber.
6. To evaluate the theories of quantum mechanics in various fields of LASERS, Materials sciences and future engineering applications.

Mapping with Program Outcomes:

Text Books:

T1. M.N.Avadhanulu and P.G. Kshirsagar, "A Text Book of Engineering Physics", S.Chand & Company Ltd, 9th Edition 2012.
T2. John Wiley "Engineering Physics",Wiley India Pvt. Ltd, 1st Edition 2014.
T3. S.O. Pillai, "Solid State Physics", New Age International, 6th Edition 2009.
T4. S.P. Basavaraju, " Engineering Physics", Revised Edition 2009.
T5. Charles Kittel, "Introduction to Solid State Physics" , 8th Edition.
T6. Arthur Beiser, "Concepts of Modern Physics" , Special Indian Edition 2009.
T7. Ajoy Ghatak, "Optics",4th Edition 2009

Reference Books:

R1. R.K. Gaur and S.L. Gupta, "Engineering Physics", Dhanpatrai and Sons, New Delhi, 2001.
R2. Sehgal Chopra Sehgal, " Modern Physics ", Tata McGraw-Hill, 6th Edition, 2005.
R3. Halliday, Resnick and Krane, "Fundamentals of Physics Extended", John Wiley and Sons Inc., New York, 5th Edition, 1997.
R4. P.Mani, "Engineering Physics", Dhanam publishers, Revised Edition 2011.
R5. H.J. Sawant, "Engineering Physics", Technical Publications, 1st Edition, 2010.
R6. V. Rajendran, "Engineering Physics", Tata Mcgraw Hill Publishing Company Limited, 1st Edition, 2009.
R7. K.Eric Drexler, "Nanosystems - Molecular Machinery, Manufacturing and Computation", John Wiely & Sons, 2005.
R8. J David, N Cheeke , "Fundamentals and Applications of Ultrasonic Waves", CRC Press 1st Edition, 2002.
R9. Frederick J Bueche and Eugene Hecht "Schaum Outline of Theory and Problems of College Physics", Tata McGraw-Hill, 11th Edition, 2012.
R10. M. Ali Omar, "Elementary Solid State Physics", Addison-Wesley 1st Edition, 1993.

Online Resources:

W1. https://en.wikipedia.org/wiki/Laser
W2. https://en.wikipedia.org/wiki/Ultrasound
W3. https://en.wikipedia.org/wiki/Optical_fiber

Course Name: Basic Electrical Engineering					
Course Code : EE133P /233P					
	L	**T**	**P**	Category	ESC
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**24**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives: This course is aimed to solve and analyse DC and AC networks. It also covers the fundamental principles of alternator, transformer, motors, renewable energy systems and power converters. It also emphasize the concepts in smart grid and electrical vehicles to cope up with current trends in electrical engineering.

Prerequisites: NA

Units	**Teaching Hours**
Unit-1 : DC circuits	
Basic electrical quantities, KCL, KVL, voltage and current division rules, circuit reduction using series, parallel and star-delta transformation of resistors. Superposition theorem, Thevenin's theorem, Source transformations- Electromagnetism- Faraday's laws, comparison of electric and magnetic circuits.	9
Unit-2: AC circuits	
Comparison of DC and AC , Generation of sinusoidal signal, Representation of AC, inductance and capacitance, behaviour of pure R, L and C in AC circuits, RL, RC and RLC series circuits- derivations, phasor diagrams, real power, reactive power, power factor and resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.	9
Unit-3: Power System Components	
Power system components-overview, Alternator-construction, working and generated voltage equation, Transformer – types, construction, working, emf equation, voltage regulation and efficiency, Switchgears (Fuse, MCB, relay), earthing, electric safety, standards and best practices. DC Motor- construction and working, torque and speed equations of shunt motors, Single phase induction motors - construction and working, BLDC motor and its applications in e-mobility.	9
Unit-4: Power Converters and Renewable Energy	
Power supplies and converters, SCR as a switch single phase rectifiers and inverters, DC power supply. Solar standalone system and its characteristics, Solar PV grid tied system description, Wind energy systems- types, types of renewable systems- stand alone, grid tied systems and hybrid and micro-grids.	9
Unit-5: Smart Grid and Electric Vehicles	
Introduction to smart grid, Home automation systems, Application of IoT in electrical systems, smart meters, communication systems in electrical systems, Artificial intelligence in power system. Introduction to electric vehicles- building blocks, charging stations. Different types of batteries and terminologies and BMS applications	9

List of Experiments:	**Practical Hours**
12. Verification of superposition theorem	**2**
13. Wiring practice – multiple switching and two way switching	**2**
14. Phase angle measurement in R, RL and RLC circuits	**2**
15. Energy measurement in single phase circuits – with R and RL loads	**2**
16. Power factor improvement	**2**
17. Regulation and efficiency of single phase transformer.	**2**
18. Speed – torque characteristics of a DC shunt motor	**2**
19. Speed – torque characteristics of single phase induction motor	**2**
20. Characteristics of solar PV modules	**2**
21. Electrical appliances control using Arduino	**2**
22. Variable DC voltage using DC-DC converter (Demonstration)	**2**
23. Power circuit control using relay and a contactor. (Demonstration)	**2**
Self-study : NA	
Site/Industrial Visits : NA	
Course outcomes: CO1: To solve DC networks CO2: To solve AC networks CO3: To understand working modes of alternator, transformer and motors CO4: To understand renewable energy systems and power converters CO5: To illustrate concepts smart grid and electrical vehicles	
Text Books: T 1.D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010. T 2.V K. Mehta, Vivek Mehta, "Principles of Power System", S. Chand, 2005, reprint 2015. T 3.D. P. Kothari and K C.Singal, "Renewable Energy Sources and Emerging Technologies", PHI, 2011. T 4.James Larminie, John Lowry, 'Electric Vehicle Technology Explained', Wiley , 2015.	
Reference Books: R 1. Weedy, Cory, Ekanayake, ' Electric Power Systems', John Wiley & Sons; 5th edition, 2012. R 2. Hina Fathima (Editor), 'Hybrid-Renewable Energy Systems in Microgrids: Integration, Developments and Control', Woodhead Publishing Series in Energy, 2018. R 3. Nikos Hatziargyriou, 'Microgrids: Architectures and Control', Wiley, 2014 R 4. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.	
Online Resources: W1. https://nptel.ac.in/courses/108108076/ W2. https://nptel.ac.in/downloads/108105053/	

Course Name: Basics of Civil Engineering and Engineering Mechanics					
Course Code : CE134P / CE234P					
	L	**T**	**P**	**Category**	**ESC**
Contact Hrs./Week	3	0	2	**CIA Marks**	**70**
Contact Hrs./Sem.	45	0	30	**ESE Marks**	**30**
Credits.	3	0	1	**Exam Hours**	**3**

Course objectives:

- The students will understand the basics of civil engineering and Engineering Mechanics
- The students will understand the basic principles and laws of forces of nature, measurements, calculations and SI units.
- The students will understand mechanics that studies the effects of forces and moments acting on rigid bodies that are either at rest or moving with constant velocity along a straight path for static condition only.
- The students will understand the basic concepts of forces in the member, centroid, moment of inertia and Kinetics of bodies.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction To Civil Engineering Scope of different fields of Civil Engineering: Surveying, Building Materials, Construction Technology, Structural Engineering, Geotechnical Engineering, Environmental Engineering, Hydraulics, Water Resources Engineering, Transportation Engineering. Role of Civil Engineers in Infrastructure Development. **Introduction to Engineering Mechanics** Basic idealizations-Particle, Continuum, Rigid body and Point force, Newtons laws of motion. Force, classification of force systems, Principle of Physical Independence of forces, Principle of Superposition of forces and Principle of Transmissibilty of forces, Moment, Couple and its characteristics. Composition and resolution of forces, Paralleologram Law of forces, Polygon law. Resultant of coplanar concurrent force systems.	9
Unit-2	
Composition of Coplanar Concurrent and Non Concurrent Force System. Resultant of coplanar concurrent force systems. Varignon's Theorem, Resultant of coplanar non concurrent force systems. **Equilibrium of force systems** Free body Diagram, Lami's Theorem ,Equations of Equilibrium, Equilibrium of coplanar concurrent forces.	9
Unit-3	
Support Reactions Types of loads and supports, Types of beams, Statically determinate and indeterminate beams, Support Reactions in beams, Numerical Problems on	9

support reactions for statically determinate beams (point load, Uniformly distributed load, Uniformly varying load and moments) .	
Unit-4	
Centroid and Moment of inertia Definition of centroid and centre of gravity, Centroid of simple plane figures and built up sections. Moment of inertia / Second Moment of area, Parallel axis theorem and Perpendicular axis theorem, Moment of Inertia of composite areas, Polar Moment of inertia and radius of gyration.	9
Unit-5	
Kinematics Definitions, Displacement, Average velocity, Instantaneous Velocity, Speed, Acceleration, Average Acceleration, Variable Acceleration, Acceleration due to gravity.Types of motion-Rectilinear, Curvilinear and Projectile motion. Relative motion and Motion under Gravity, Numerical Problems. Kinetics: D Alemberts Principle and its application in Plane motion.	9
List of Experiments (If any):	**Practical Hours**
1.To determine moisture content of fine Aggregates.	2
2.Sieve Analysis of Fine Aggregates.	2
3.Determination of Compressive Strength of Burnt Clay Bricks.	2
4. Determination of Fineness of Cement.	2
5. Setting out of rectangle in the field.	2
6. Setting out of polygon in the field.	2
7. To Verify the Polygon Law of Forces Using Universal Force Table.	2
8. To Verify Parallelogram Law of Forces Using Grave Sand's Apparatus.	2
9. To Determine Weight of Body Using Grave Sand's Apparatus.	2
10. To Verify Triangular law of Forces using Jib Crane Apparatus.	2
11. To determine the reactions for simply supported beam Using Parallel Force Apparatus.	2
12. To determine the center of gravity Using Parallel Force Apparatus.	2
Self-study: NA	
Site/Industrial Visits : Nil	
Course outcomes: After a successful completion of the course, the student will be able to: **CO1:** Understand basics of Civil Engineering, its scope of study and materials of construction.(L1)(PO1)(PSO1) **CO2**: Comprehend the action of Forces, Moments and other loads on systems of rigid bodies.(L2)(PO1,PO2)(PSO2) **CO3:** Compute the reactive forces and the effects that develop as a result of the external loads.(L3)(PO1)(PSO2)	

CO4: Compute Centroid and Moment of Inertia of regular and built up sections.(L3)(PO1)(PSO1)

CO5: Express the relationship between the motion of bodies and equipped to pursue studies in allied courses in Mechanics. (L3) (PO1,PO2) (PSO1)

Text Books:

T1. Bhavikatti S.S. *Elements of Civil Engineering*, 4th Edition and *Engineering Mechanics* ,2nd edition, New Delhi, Vikas Publishing House Pvt. Ltd, 2008.

T2. Shesh Prakash and Mogaveer, Elements *of Civil Engineering and Engineering Mechanics*, 1st edition, New Delhi , PHI learning Private Limited,2009.

T3. Jagadeesh T.R. and Jay Ram, *Elements of Civil Engineering and Engineering Mechanics*, 2nd edition, Bangalore, Sapana Book House, 2008.

Reference Books:

R1. Timoshenko, and Young, Engineering Mechanics, Tata McGraw-Hill, New Delhi, 2013.

R2. Meriam J. L, and Kraige, L. G, Engineering Mechanics, 5/E, Volume I, Wiley India Edition, India, Feburary 2018

R3. Irvingh H Shames, Engineering Mechanics, 4/E, PHI learning Private Limited, New Delhi, 2008

R4. Ferdinand P. Beer and E. Russel Johnston Jr., Mechanics for Engineers: Statics, McGraw-Hill Book Company, New Delhi. International Edition 2013

R5. Bansal R. K, Engineering Mechanics, Laxmi Publications (P) Ltd, New Delhi, 2015

Goyal and Raghuvanshi, Engineering Mechanics, New Edition, PHI learning Private Limited, New Delhi. 2011

R6. Rajasekaran, S, Sankarasubramanian, G., Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt., Ltd., 2011.

R6. Kukreja C.B., Kishore K.Ravi Chawla., Material Testing Laboratory Manual, Standard Publishers & Distributors 1996.

R7. Gambhir M.L., Concrete Manual, Dhanpat Rai & Sons, New Delhi, 2014

Duggal S.K., Surveying, Vol-I, Tata McGraw Hill - Publishing Co. Ltd. New Delhi.

R8. Punmia. B.C., Surveying Vol–1, Laxmi Publications, New Delhi.

Online Resources:

W1.https://nptel.ac.in/courses/112103109/

W2. https://nptel.ac.in/courses/122104015/

Course Name: Engineering Graphics					
Course Code : EG 135P / EG 235P					
	L	**T**	**P**	Category	**ESC**
Contact Hrs./Week	**2**	**0**	**2**	CIA Marks	**50**
Contact Hrs./Sem.	**30**	**0**	**30**	ESE Marks	**50**
Credits.	**2**	**0**	**1**	Exam Hours	**3**

Course objectives:

- To create an awareness and emphasize the need for Engineering Graphics.
- To teach basic drawing standards and conventions.
- To develop skills in three-dimensional visualization of engineering components.
- To develop an understanding of 2D and 3D drawings using the Solidworks software

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Introduction to Engineering Drawing& Orthographic Projections	
Introduction to Engineering Drawing Principles of Engineering Graphics and their significance, usage of Drawing instruments, BIS conventions, lettering, Scales – Plain, Diagonal and Vernier Scales. **Orthographic Projections (First Angle Projection Only)** Principles of orthographic projections, introduction to first angle and third angle projection, projections of points, lines (inclined to both planes) and planes. (No application problems)	**14**
Unit-2: Introduction of Computer Aided Engineering Drawing	
Introduction of Computer Aided Engineering Drawing (CAED) Introduction and customization of user interface consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning, orthographic constraints, snap to objects manually and automatically, producing drawings by using various coordinate input entry methods to draw straight lines, applying various ways of drawing circles. Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings, setting up and use of layers, layers to create drawings, create, edit and use customized layers, changing line lengths through modifying existing lines.	**2**
Unit-3: Projections of Regular Solids &Sections of solids	
Projections of Regular Solids Projection of solids inclined to both the Planes, draw simple annotation, dimensioning and scale (both manual and CAD software). **Sections of solids** Sections and sectional views of right angular solids - Prism, Cylinder, Pyramid, Cone– Auxiliary Views; (both manual and CAD software)	**20**
Unit-4: Development of surfaces & Isometric Projections	

Development of surfaces Development of surfaces of right regular solids - prism, pyramid, cylinder and cone; draw the sectional orthographic views of geometrical solids. **Isometric Projections** Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of simple and compound Solids, conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.	**20**
Unit-5: Overview of Computer Graphics & Introduction to Modeling and Assembly	
Overview of Computer Graphics Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Projection of solids, Isometric of Simple and compound Solids, sections of solids and development of surfaces. **Introduction to Modeling and Assembly** Introduction to Computer aided modeling of solid part and assembly using CAD software Parametric and non-parametric solid and wireframe models, part editing and 2D drafting of assembly.	**20**
Self-study: Three Modeling of Simple Machine Parts	
Site/Industrial Visits : Nil	
Course outcomes: CO1: Understand the importance of BIS standards and scales and be able to use it in Engineering drawings and be Able to graphically construct geometric 2 Dimensional figures with hand tools and solve numericals related to them. {L1,L2}{PO1} CO2: Use the CAD software and be able to create basic 2D computer geometries like points, lines, and planes. {L1,L2}{PO1,PO2} CO3: Understand the concept of projection and sectioning of solids and be able to create the drawings manually. {L1,L2}{PO1,PO2} CO4: To create Drawings of surfaces of regular solids after development Manually. {L1,L2}{PO1,PO2} CO5: To create isometric drawings from Orthographic projections by using isometric scale Manually and using CAD software. {L1,L2}{PO2,PO5} CO6: To create projection of solids, sectioning development of surface using CAD software and be able to draw basic 3D shapes in CAD. {L1,L2}{PO2,PO5}	
Text Books: T1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House T2. N S Parthasarathy and Vela Murali (2015) Engineering Drawing, Oxford University Press T3. Shah, M.B. & Rana B.C. (2009), Engineering Drawing and Computer Graphics, Pearson Education T4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication	

Reference Books:

R1. S. Trymbaka Murthy, "Computer Aided Engineering Drawing", I.K. International Publishing House Pvt. Ltd., New Delhi.
R2. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech
R3. K.R. Gopalakrishna, "Engineering Graphics", 15th Edition, Subash Publishers Bangalore

Online Resources:

W1. https://nptel.ac.in/

COURSE NAME: BIO SCIENCE					
Course Code : BS 136 / BS 236					
	L	**T**	**P**	Course Type	**BSC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

It is well known that this is the century of biology in which significant advances in the understanding and application of biological systems are expected. The significant impact on the world is expected in terms of better healthcare, better processes, better products and an overall better quality of life. Thus, any person can be interested in knowing the fundamentals of biology to be able to understand, or participate in the biological revolution. For example, any engineer, irrespective of the parent discipline (mechanical, electrical, civil, chemical, metallurgical, etc.,) has a high probability of using the disciplinary skills toward designing/improving biological systems in the future.

Prerequisites: Write course names if any, Otherwise leave blank

- **Fundamental understanding of biological processes.**

Units	**Teaching Hours**
Unit-1: Introduction to Cell structure and biomechanism	
Biological Engineering - Classifications-Taxonomy- Prokaryotes and Eukaryotes- Morphology, NucleusProtein structure and function - Organelles for Protein synthesis and transport- Cell division - mitosis, meiosis- Biochemical pathways - metabolism, energy conversion, TCA cycle, electron transport, ATP, glycolysis, photosynthesis- DNA structure - Replication- Transcription- Translation	09
Unit-2: Biosensors	
General principles - Construction of biosensors, immobilization of receptor components in biosensors- Types –metabolism, semiconductor, optical, piezoelectric, immunosensors - Applications – lab-on-a-chip, food and beverage, defence, environmental applications, Medical instruments	10
Unit-3: Modern Imaging systems	
X ray, digital radiography – x-ray computed tomography- Nuclear medical imaging systems, Magnetic resonance imaging system, Ultrasonic imaging system, thermal imaging, haemodialysis system, anaesthesia and ventilator systems.	8
Unit-4: Biomechanics	
Key mechanical concepts - 9 fundamentals of biomechanics -Muscle action, Range of motion principle, Force motion principle - Tissue loads -Response of tissue to force - Biomechanics of passive muscle tendon unit- Biomechanics of bone - Biomechanics of ligaments - Mechanical characteristics of muscles- Force time principle - Stretch-shortening cycle	10
Unit-5: Materials for organs and devices	

Materials – polymers, metals, ceramics, hydrogels, degradable biomaterials - Host reaction to biomaterials and their evaluation -Application of biomaterials – heart valves, orthopaedic applications, Cochlear and dental implants, soft tissue replacements, Hard tissue replacements	8

Self-study: NA

Site/Industrial Visits: NA

Course outcomes:

At the end of the course, the student will be able to do:

1. Discuss the hierarchical of life and the classification of species.
2. The student would be able to differentiate between single celled and multi-cellular organisms based on their cell structure.
3. Explain about structure, types and functioning of key components as proteins, carbohydrates, fats and DNA/RNA.
4. The student will be able to elaborate on the different pathways for energy production, cell division, photosynthesis and genetic transfer.
5. Discuss about the construction and working of biosensors for various applications.
6. Discuss about the architecture and organization of implantable electronics, which are used to sense and monitor different body functions.
7. Discuss the fundamental of the common laboratory equipment, its functioning and the electronics associated with it.

Text Books:

T1. F. Scheller, F. Schubert, (1991) *Biosensors,Volume 11 of Techniques and Instrumentation in Analytical Chemistry*, Elsevier.

T2. Vinod Kumar Khanna, (2015) *Implantable Medical Electronics: Prosthetics, Drug Delivery, and Health Monitoring*, Springer.

T3.Khandpur, (2003) *Handbook of Biomedical Instrumentation*, Tata McGraw-Hill Education

T4. David A. Winter, (2009) *Biomechanics and Motor Control of Human Movement*, John Wiley & Sons.

T5.Duane Knudson, (2013) *Fundamentals of Biomechanics*, Springer Science & Business Media.

T6. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, (2012) *Biomaterials Science: An Introduction to Materials in Medicine*, Academic Press.

Reference Books:

R1. Bansi Dhar Malhotra, Anthony Turner, (2003) Advances in Biosensors: Perspectives in Biosensors, *Volume 5 of Advances in Biosensors*, Elsevier.

Online Resources:

W1. http://nptel.ac.in

III SEMESTER

COURSE NAME: MATHEMATICS III					
COURSE CODE :MA331					
	L	**T**	**P**	Category	**BSC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3 hrs.**

Course objectives:
This course develops the skills of the students in the areas of mechanical as well civil engineering. It will prepare the students for their effective studies in a large number of core engineering subjects.

Prerequisites: Knowledge of Mathematics I & II

Units	**Teaching Hours**
Unit-1: Fourier Series	
Periodic functions, Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine and cosine series – Complex form of Fourier Series – Harmonic Analysis.	**9**
Unit-2:Fourier Transform	
Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Transform of the derivative and the derivative of the transform - Convolution theorem – Parseval's identity.	**9**
Unit-3: Partial Differential Equations	
Formation of PDE, Solution of homogeneous PDE involving derivative with respect to one independent variable only (Both types with given set of conditions), solution of non-homogeneous PDE by direct integration, Method of separation of variables. (First and second order equations) Solution of Lagrange's linear PDE of the type $P\,p + Q\,q = R$ Derivation of one dimensional wave and heat equations.Various possible solutions of these by the method of separation of variables.D'Alembert's solution of wave equation.Two dimensional Laplace's equation – various possible solutions.Solution of all these equations with specified boundary conditions. (Boundary value problems)	**9**
Unit-4:Numerical Methods – I	
Numerical solutions of algebraic and transcendental equations by Newton - Raphson and Regula - Falsi methods. Finite differences (Forward and Backward differences) Interpolation, Newton's forward and backward interpolation formulae.Divided differences – Newton's divided difference formula.Lagrange's interpolation and inverse interpolation formulae.	**9**
Unit-5: Calculus of Variations	
Variation of a function, Variational problems, Euler's equation and its solution, Standard variation problems including geodesics, minimal surface of revolution, hanging chain and Brachistochrone problems. Functional, functionals involving higher order derivatives.	**9**

Course outcomes:

CO1: Expand the function as a Fourier series and harmonic analysis of the given data. {L1} {PO1}

CO2: Form the partial differential equations and solve it by methods of variable separable, Fourier series, D'Alembert's. {L1} {PO1}

CO3: Solve the algebraic and transcendental equations by Newton - Raphson and Regula - Falsi methods. {L2} {PO2}

CO4: Interpolate and Extrapolate the data of equal and unequal intervals by applying finite differences, Divided differences, Lagrange's interpolation and inverse interpolation formulae. {L3} {PO2}

CO5: Find the optimal values of the functional by applying Euler's equation. {L2} {PO2}

Text Books:

1. "Basic and Applied Thermodynamics" by P.K. Nag, Tata McGraw Hill, 3rd Edi. 2002

2. "Thermodynamics an engineering approach", by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub. 2002

Reference Books:

1. Engineering Thermodynamics. By Rajput, Laxmi Publications pvt ltd., 3rd Edi. 2007.

2. Engineering Thermodynamics by J.B. Jones and G.A.Hawkins, John Wiley and Sons.

3. Thermo Dynamics by S.C.Gupta, Pearson Edu. Pvt. Ltd., 1st Ed. 2005.

COURSE NAME: THERMAL ENGINEERING					
COURSE CODE :RM332					
	L	**T**	**P**	Category	
Contact Hrs./Week	**2**	**1**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3 hrs.**

Course objectives:

1. The course aims at to cover the basic principles of thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice.
2. To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.
3. To learn the basics of heat engine, heat pump, refrigerator and Carnot principle and their Practical applications.
4. To read the basics of combustion, air fuel ratio required and their Practical application

Prerequisites:

Units	**Teaching Hours**
Unit-1: Introduction, Work and Heat	
Introduction: Types of thermodynamics System, closed open and isolated systems, Microscopic and Macroscopic approaches, Thermodynamic properties, definition and units, intensive and extensive properties. Thermodynamic state process and cycle, path and point function, quasi-static process,cyclic and non-cyclic processes,Thermodynamic equilibrium, mechanical equilibrium, thermalequilibrium, chemical equilibrium-Equality of temperature Zeroth law of thermodynamics,Temperature,concepts, scales and measurement. Numerical. **Work and Heat:**MechanicsDefinition of Work and limitations, Thermodynamic definition of work,examples sign convention. Displacement work, expressions for displacement work in variousprocesses through p-v diagrams. Show that work as path function, Electrical work, Paddle wheel workand flow work. Heat: definitions, units, sign convention, specific heats, show that heat is a pathfunction. Comparison between work and heat. Simple numerical.	**9**
Unit-2:First and Second Law of Thermodynamics	
First Law of Thermodynamics: Joule's experiments, First law for a closed system undergoing acycle,First law for a closed system undergoing a change of state, Energy– A property of a system,Energy balance for closed system,different forms of stored energy,Enthalpy, Specific heat atconstant volume, and constant pressure,PMM1,control volume, study flow process,Mass andenergy balance for study flow process,somestudy flow engineering devices,Limitations of first lawof thermodynamics Numerical. **Second Law of Thermodynamics:** Introduction to second law,Qualitative difference between heat and work, Cyclicheat engine,Thermal energy reservoirs,Kelvin-Plank statement and Clausius statement of second law ofThermodynamics,Refrigerator and heat pump, equivalence of bothstatements,PMM II Reversibilityand irreversibility,	**9**

causes of irreversibility,Carnot cycle, Reversedheat engine,Carnot's theorem,corollary of Carnot's theorem,Absolute thermodynamic temperature scale,Numerical.	
Unit-3: Combustion Thermodynamics and Air Standard Cycles	
Combustion Thermodynamics: Theoretical (Stoichiometric) air and excess air for combustion offuels, Mass and volume balance and actual combustion, Exhaust gas analysis, A/F ratio, Energybalance for a chemical reaction,enthalpy of formation, enthalpy of combustion and internal energy ofcombustion, combustion efficiency adiabatic flame temperature,Lower and higher calorific value offuel, numerical problems. **Air Standard Cycles:**Assumptions during analysis of air standard cycles,Air standard cycles like-Carnot, Otto, Diesel, Dual and Stirling cycles,Represent of cycles on P-V and T-S diagrams,Equations for efficiencies and mean effective pressures,Comparison of Otto, diesel and Dual cycles,related simple Numericals.	**9**
Unit-4:Testing of IC Engines, Gas Turbines and Jet Propulsion	
Testing of IC Engines: Performance of engines, objectives and parameters for testing of engines,Basic definitions of Indicated power, Brake power, fuel consumption, BSFC and A/F ratio,Mechanical, Thermal, Volumetric and Relative efficiencies of engines,Testing of two-stroke and fourstroke SI and CI engines for performance,Measurement of frictional power by various methods, studyon heat balance sheet and related numerical. **Gas Turbines and Jet Propulsion:**Classification of Gas turbines,Gas turbine (Brayton) cycle,description and analysis of open cycle gas turbine,Derivations of equations for efficiency, work ratioand Pressure ratio for maximum power output,actual gas turbine cycles, Numerical problems,Methods to improve thermal efficiency of gas turbines(no numerical), Jet propulsion and Rocketpropulsion.	**9**
Unit-5:	
Ideal Gas Mixture: Dalton's law of additive pressures, Amagat's law of additive volumes, evaluation of properties. Analysis of various processes. **Real Gas:** Introduction; Vander Waal's Equation Van der Waal's constants in terms of critical properties, law of corresponding states, compressibility factor; compressibility}" chart.	**9**
Course outcomes: 1. Describe the fundamental concepts of thermodynamic systems and various processes of heat and work interactions 2. Discussofthe First and second law of thermodynamics and analysis of flow processes in different applications 3. Definethe basic concepts and definitions used in applied thermodynamics. 4. Explainandcalculatethe performance characteristics ofIC Engines and Gas turbine. 5. Examine ideal and real gas behaviour using thermodynamic relations.	
Text Books: 1. Nag P.K.Basic & Applied Thermodynamics. Tata McGraw Hill Pub. Co. 2002. 2. Rajput R.K,Thermal Engineering. Lakshmi publications.	
Reference Books:	

1. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics-An Engineering Approach",TataMcGraw-Hill.2002.
2. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, Prentice-hall of India Pvt.Ltd.
3. G J Van Wylen and R E Sonntag, "Fundamental of Classical Thermodynamics", WileyEastern.1st edition,2002

COURSE NAME: STRENGTH OF MATERIALS					
COURSE CODE :ME333P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**1**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives: To study the behaviour of material under different loading conditions, and study of various stress, strain and deformation on a material without undergoing failure or plastic deformation.

Prerequisites: Basic knowledge of Engineering Mathematics, Engineering Mechanics.

Units	**Teaching Hours**
Unit-1: Simple Stress-Strain Theory	
Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.	**9**
Unit-2: Shear force and Bending Moment Diagram, Shear and Bending stress Distribution	
Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.	**9**
Unit-3: Deflection of Beams	
Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.	**9**
Unit-4: Simple Torsional Theory	
Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.	**9**
Unit-5: Thick and Thin Cylinders	
Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.	**9**

List of Experiments:	**Practical Hours** **30**
PART-A	
1. Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.	**4**
2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.	**2**
3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	**2**
4. Non-destructive test experiments like, {a}. Ultrasonic flaw detection {b}. Magnetic crack detection {c}. Dye penetration testing. To study the defects of Cast and Welded specimens	**4**
PART-B	
5. Tensile, shear and compression tests of metallic and non-metallic specimens using Universal Testing Machine.	**4**
6. Torsion Test	**2**
7. Bending Test on metallic and nonmetallic specimens.	**2**
8. Izod and Charpy Tests on M.S,C.I Specimen.	**2**
9. Brinell, Rockwell and Vickers's Hardness test.	**2**
10. Fatigue Test.	**2**
Self-study: Introduction to column theory, Uniaxial, Biaxial and Triaxial stresses.	
Site/Industrial Visits: One industrial visit planned.	
Course outcomes: CO1: Demonstrate an understanding of the relationships between stress strain, member forces and deformations for homogenous and isotropic material. {L1,L2}{PO1, PO2} CO2: Calculate the stresses, strain and elongation/Contraction in a bars, Torsional systems, cylinders and columns. {L1,L2,L3}{PO1, PO2,PO3} CO3: Solving the problems on Shear force and Bending Moment diagram for a beam subjected to point load, UDL, UVL and Moment. {L1,L2,L4}{PO1, PO2,PO4}	

CO4: Finding the maximum deflection of beam by double integration method. {L1,L2,L3}{PO1, PO2,PO3}

CO5: Determine and illustrate principal stresses, maximum shearing stress, and the stresses acting on a structural Member. {L1,L2}{PO1, PO2}

Text Books:

T1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.

T2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.

T3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGrawHill Publishing Co. Ltd., New Delhi 2005.

T4. R.C.hibbeler, "Mechanics of materials", 9Edition,Printice hall. pearson edu., 2014.

T5. James.m.gere;Stephe Timoshenko, "Mechanics of materials",2nd Edition CBS Publishers, 2016.

T6. Ferdinand P Beer; E. Russel Johnson;John T Dewolf;David F Mazurek; Sanjeev. Sanghi,"Mechanics of materials", Tata mcgrawhill- 2013.

Reference Books:

R1. S.S. Rattan, "Strength of Materials",3rdEdition, Tata McGraw Hill, 2011.

R2. S.S.Bhavikatti, "Strength of Materials", 4thEdition,Vikas publications House Pvt. Ltd., 2013.

R3. K.V. Rao, G.C. Raju, "Mechanics of Materials", First Edition, 2007

R4. Egor.P. Popov,"Engineering Mechanics of Solids", Pearson Edu. India, 2008.

R5. W.A. Nash, Schaum's Outlines Strength of Materials,Tata Mcgraw-Hill Publishing Company 2010.

R6 R.K. Rajput"Strength of Materials",S.Chand & co Ltd. New Delhi, 2015

R7 R.KBansal, "Strength of Materials",Lakshmi Publication {P} Ltd, New Delhi,2009.

Online Resources:

W1. NPTEL

W2. edX

W3. Coursera

COURSE NAME: ANALOG AND DIGITALCIRCUITS					
COURSE CODE :RM334P					
	L	**T**	**P**	Category	
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

1. Provide the basics behind the digital circuit design, in terms of all the necessary buildingblocks.
2. Illustrate Boolean laws and systematic techniques for minimization of expressions.
3. Introduce the Basic concepts of combinational and sequential logic.
4. Perform a load-line analysis of the most common BJT configurations.
5. Become acquainted with the design process for BJT biasing.
6. Analyze the concepts of Oscillator circuits.

Prerequisites: Number System, Semiconductor Basics.

Units	**Teaching Hours**
Unit-1: Combinational Circuits:	
Introduction to combinational logic circuits, generation of switching equation from truth tableMinimization Techniques: Boolean algebra, expression minimization. Min-term, Max-term, Sum ofProducts (SOP), Product of Sums (POS), Karnaugh map. Analysis anddesign of Adder/Subtractor,Carry Look Ahead adder, BCD adder. Principle of Encoder and Decoder	**9**
Unit-2:Introduction to Sequential circuits:	
Basic bi-stable element, S R Latch, Flip-flops-SR, JK, D, T, and Master-Slave–Characteristic tableand equation. Registers, Shift Register, Counters: Binary Ripple Up/Down Counter, Design ofsynchronous Mod-n counter using flip-flop.	**9**
Unit-3:Transistor and its Biasing Techniques:	
Construction and Operation of a Transistor, characteristics (CB and CE), operating point, Biasingtechniques (Emitter Based Biasing and Voltage divider biasing). Oscillators: RC Phase shift, Hartleyand Colpitts Oscillator. Numerical related to above topics.	**9**
Unit-4: Introduction to Operational Amplifiers:	
Basic Operational Amplifier Circuit, The 741 IC Op-Amp, Voltage Follower, Non-inverting and InvertingAmplifiers. Operational Amplifier Parameters.Problems linked to above topics.	**9**
Unit-5: Oscillators and Comparators, Comparators and 555 timers and Its applications	
Oscillators and Comparators: Principles, Types, Frequency Stability, phase shift oscillator, wein bridge oscillator. Comparators: Basic comparators, zero crossing detector, Schmitt trigger and problems.	**9**

555 timers and Its applications: Introduction, the 555 timer pin diagram, architecture of 555 timers, 555 timer as monostable multivibrator, 555 timer as astable multivibrator, applications of astable multivibrator. Problems.	
List of Experiments :	**Practical Hours**
1. Realization of parallel Adder and Subtractor. 2. Realization of 3 bit Binary to Grey code conversion and vice versa using basic/Universal gates. 3. Realization of 4:1 MUX and 1:4 DEMUX using basic/universal gates. 4. Arithmetic circuit realization (Half/Full, Adder/Subtractor) using MUX. 5. Construction and verification of JK master slave, T, D flip flop using logic gates. 6. Design a Single stage BJT RC Coupled Amplifier and obtain frequency response curve and findBandwidth, Input & Output Impedances. 7. Design a Two stage voltage series BJT Amplifier and Obtain frequency response curve, also findBandwidth, Input & Output Impedances 8. Rig-up an R-C Phase Shift oscillator for fo ≤ 10 KHz & Crystal oscillators for fo>1MHz. 9. Design a BJT Hartley &Colpitts's Oscillators for frequency ≥100kHz & simulate the circuit in Multisim. 10. Design an OPAMP Inverting & Non-Inverting Amplifier.	

Course outcomes:

By the end of the course the student shall be able to

1. Compute the DC values of voltages and currents in biasing circuits.
2. Analyze various BJT amplifiers for CE, CC, and CB configurations.
3. Construct sinusoidal, non-sinusoidal oscillators and power amplifiers.
4. Analyze direct coupled operational amplifiers.
5. Define a Boolean term, expression, SOP, POS, Min-term etc.
6. Determine the output and performance of given combinational and sequential circuits.
7. Design arithmetic and combinational logic circuits using gates, encoders, decoders,multiplexers and demultiplexers.

Text Books:

1. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 1st Edition, 2001.
2. Donald D Givone, "Digital Principles and Design", Tata McGraw-Hill 1st Edition, 2002.
3. Robert L.Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th editionPHI/Pearson Education. 2015.
4. David A. Bell, "Electronic Devices & Circuits", 4thEdition, Prentice Hall of India/Pearson Education,ninth printing, 2007.
5. David A. Bell, "Operational Amplifiers and Linear ICs", 2ndEdition, Prentice Hall of India, 2006.

Reference Books:

1. Floyd, "Electronic Devices", 6thEdition, Prentice Hall of India, Pearson Education.2010.

2. Moshe Morris Mano, "Digital Design" Prentice Hall, 3rdEdition, 2008.

COURSE NAME: INSTRUMENTATION AND CONTROL					
COURSE CODE : ME335P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3 hrs**

Course objectives:

1. To provide a basic knowledge about measurement systems and their components
2. To learn about various sensors used for measurement of mechanical quantities
3. To learn about system stability and control
4. To integrate the measurement systems with the process for process monitoring andcontrol

Prerequisites: -Nil-

Units	**Teaching Hours**
Unit-1:Measurement Systems and Performance	
Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.	9
Unit-2:Instrumentation System Elements	
Measurement of Force, Torque: Principle, analytical balance,platform balance, proving ring. Torque measurement, Prony brake, hydraulicdynamometer. **Pressure Measurements:**principle, use of elastic merijbers, Bridgemangauge, Mcloed gauge, Pirani gauge,Surface Finish Metrology	10
Unit-3:Signal Processing and Conditioning	
Mechanical systems, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters,Machine tool Metrology,Introduction to atomic force microscopy {AFM}, Scanning tunneling microscopy {STM}, Nano metrology	8
Unit-4:Control Systems	
Temperature Measurement: Resistance thermometers, thermocouple, law of thermo couple, materials used for construction, pyrometer, optical pyrometer. **Strain Measurements**: strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement.	10
Unit-5: Standards of Measurement	

Definition and Objectives of metrology, Standards of length-International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars {Numerical}, Slip gauges, Wringing phenomena, Legal Metrology, Care of Measuring Instruments- Reliability.	8
List of Experiments :	**Practical Hours**
1. Calibration of Pressure Gauge	**2**
2. Calibration of Thermocouple	**2**
3. Calibration of LVDT	**2**
4. Calibration of Load cell	**2**
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.	**2**
6. Measurements using Optical Projector	**2**
7. Measurements using Tool makers microscope	**2**
8. Measurement of angle using Sine Center	**1**
9. Measurement of angle using bevel protractor	**1**
10. Measurement of alignment using Autocollimator	**2**
11. Measurement of cutting tool forces using Lathe tool dynamometer	**2**
12. Measurement of cutting tool forces using drill tool dynamometer	**2**
13. Measurement of Screw thread Parameters using Two wire method by FCM	**2**
14. Measurement of Screw thread Parameters using Three wire method by FCM	**2**
15. Measurement of gear tooth profile using gear tooth vernie	**2**
16. Calibration of Micrometer using slip gauges	**2**
17. Calibration of thread pitch gauge	**1**
Total Hours	**30**
Self-study : Nil	
Site/Industrial Visits : Nil	
Course outcomes: CO-1: Interpret the parameters of Transducers. {Level-2} CO-2: Operate & infer the values of Torque measurement equipment{Level-1} CO-3:Interpret the readings of Cathode ray oscilloscope.{Level-2} CO-4: Compute the strain from the strain gauge equipment.{Level-1} CO-5:Examine the Line standards by slip gauges.{Level-2}	
Text Books:	

T1. Thomas G. Beckwith , Roy D. Marangon, John H. Lienhard ,"Mechanical Measurements", 6th Edition, Pearson education, 2014
T2. R K Jain, "Engineering Metrology",17thEdition, ISBN: 717409024X; ©1999 Khanna Publications Delhi; 2009
T3.Connie L Dotson,"Fundamentals of Dimensional Metrology" 5th edition, Delmar Cengage Learning, 2006

Reference Books:

R1 .I C Gupta,"A Text Book Of Engineering Metrology",7th Edition, Dhanpat Rai Publications {P} Ltd.-New Delhi,
R2. Jerry Faulk, Al Sutko,"Industrial Instrumentation"1st Edition, ISBN-13: 978-0827361256, Thompson Asia Pvt. Ltd.2002.
R3.Ernest, "Measurement Systems Application", 1st Edition, ISBN-13: 978-0070173385, McGraw-Hill Book Company.
R4. R.S.Sirohi,"Mechanical measurements"3rd Edition, ISBN-8122403832, New Age Publications, 1991.

Online Resources:

W1. http://nptel.ac.in/

COURSE NAME: BIO SCIENCE LABORATORY					
COURSE CODE: BS351					
	L	**T**	**P**	Category	**BSC**
Contact Hrs./Week	**0**	**0**	**2**	CIA Marks	**25**
Contact Hrs./Sem.	**0**	**0**	**30**	ESE Marks	**25**
Credits.	**0**	**0**	**1**	Exam Hours	**2 hrs**

Course objectives:

The aim of this course is to familiarize the student with the analysis and design of feedback amplifiers, oscillators, tuned amplifiers, wave shaping circuits, multivibrators and blocking oscillators.

Prerequisites: Nil

List of Experiments {If any}:	**Practical Hours**
1. Blood Pressure Measurement using Arduino	2
2. Measuring HRV using the data from pulse measurement in Matlab.	4
3. Measure heart rate and SPO2 with Arduino	2
4. Measuring BMI, heart rate, SPO2, HRV using MATLAB and indicating health of person.	4
5. Analyzing breast cancer, EEG, ECG and CT images using MATLAB from online data sources and detecting irregularties (arrhythmia, tumor, cancer, epilepsy).	4
6. Analyzing force developed in muscles when performing any given task (to move servo motor and subsequently robotic arm).	4
7. Measuring water content in given soil using temperature, pH using Arduino.	4
8. IR thermal imaging to determine effect of mobile radiation.	2
9. Synthesis of biopolymers from starch.	4

Self-study : Nil

Site/Industrial Visits : Nil

Course outcomes: At the end of the course, the student will be able to do:

(CO1) Examine the applications of bioengineering using Arduino boards and sensors. (L4)

(CO2) Analyse medical information using MATLAB (L4)

(CO3) Infer medical diagnostic information from the experimental data. (L4)

Text Books:

NA

Reference Books:

NA

Online Resources:

Nil

IV SEMESTER

COURSE NAME: KINEMATICS AND THEORY OF MACHINES					
COURSE CODE : RM431					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
3. To be able to design some linkage mechanisms and cam systems to generate specified output motion
4. To understand the kinematics of gear trains

Prerequisites: Engineering Graphics, Engineering Mechanics

Units	**Teaching Hours**
Unit-1	
Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashoff's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms	**9**
Unit-2	
Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Coriolis component of acceleration- introduction to linkage synthesis-three position graphical synthesis for motion and path generation	**9**
Unit-3	
Classification of cams and followers- Terminology and definitions- Displacement diagrams-Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers	**9**
Unit-4	

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics	**9**
Unit-5	
Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication-friction clutches- belt and rope drives- friction in brakes	**9**
List of Experiments {If any}:	**Practical Hours**
Creating Frames Using Rigid Transforms	**2**
Creating a Simple Part	**2**
Creating a Complex Part	**2**
Assembling Parts into a Double Pendulum	**3**
Assembling Parts into a Four Bar Mechanism	**3**
Model a Closed-Loop Kinematic Chain	**2**
How to Build a Model	**2**
Modeling Constant Velocity Joints - Power Take-Off Shaft	**2**
Using the Common Gear Block - Cardan Gear Mechanism	**3**
Using the Rack-Pinion Block - Windshield Wiper Mechanism	**3**
Using the Common Gear Block	**3**
Using the Worm and Gear Constraint Block - Solar Tracker	**3**
Self-study : Nil	
Site/Industrial Visits : Nil	
Course outcomes: CO1: { Summarize the fundamentals of kinematics and Planar mechanisms} {L1} {PO1} CO2: {Analyse velocity and acceleration parameters in various four bar mechanisms using instantaneous centre method and relative velocity method} {L2, L3} {PO2} CO3: {Develop the displacement diagram for a required output and design cam profiles for inline and offset followers}{L4}{PO1,PO2,PO3} CO4: { Explain the fundamentals of gear profiles and extrapolate various parameters of Spur gear teeth.}{L2}{PO1,PO2} CO5: {Design gear trains for power transmission}{L2}{PO1,PO2,PO3}	

Text Books: T1. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988. T2. Ratan.S.S, "Theory of Machines", 4th Edition, Tata McGraw Hill Publishing company Ltd. 2014.
Reference Books: R1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005. R2. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005. R3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
Online Resources: W1. https://nptel.ac.in/courses/112104121/ W2. Nil

COURSE NAME: MICROCONTROLLERS ANDAPPLICATIONS					
COURSE CODE :RM432P					
	L	**T**	**P**	Category	
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

1. To introduce the microcontroller systems and learn the assembly level programming language.
2. To understand the architecture of 8051 microcontroller
3. To familiarize with the 8051-microcontroller instruction set, registers.
4. Tofamiliarize with 8051 microcontroller subsystems, such as timer modules.
5. To interface a microcontroller with common peripheral devices, such as switches, visualdisplays, digital-to-analog converters, analog-to-digital converters, and memory to produce asystem to accomplish a specified task.

Prerequisites:

Units	**Teaching Hours**
Unit-1: 8051 Architecture, Addressing Modes	
Introduction to Microprocessors and Microcontrollers, Microprocessor 8085 architecture,Microprocessor8086 architecture, The 8051 Architecture, Memory organization, Addressing Modes.	9
Unit-2:Instruction Set, Introduction to Timers/Counters	
Data transfer Instructions, Stack and Assembly language programs.Arithmetic instructions, Logicalinstructions, Branch instructions, Bit manipulation instruction, Instruction delay calculations,Assembly language programs. Introduction to Timers and Counters.	**9**
Unit-3:Modes of Timers/Counters, Interrupts and Serial Communication.	
Time delay calculations, Basics of interrupts, 8051 interrupt structure, Serial Communication: Data communication, connections to RS-232. Timers/counters, Interrupts andSerial communication programming in Assembly and C.	**9**
Unit-4: 8051 Serial Communication and Interrupts	
8051 Serial Communication and Interrupts: Basics of serial Communication, 8051 connections to RS-232, 8051 Serial communication Programming, Serial port programming in C. Interrupts Programming 8051: Interrupts, Programming timer Interrupts and Serial communication Interrupts, Interrupt Priority.	**9**
Unit-5: Interfacing and Applications	
8051 Memory Interfacing, Interfacing 8051 to LCD, parallel and serial ADC0804, DAC, Steppermotor and DC Motor, Interfacing Programming in C.Add on: Overview of microcontroller familiesand their applications	**9**
List of Experiments	**Practical Hours**

Section-A (Assembly Language Programming)

1. Data Transfer Instructions: Data Transfer between internal and external RAM with andwithout overlap, Sorting, largest and smallest number in an array and exchange.
2. Arithmetic Instructions: 32-bit multi-precision Addition, Subtraction, Multiplication of 2 16bit numbers and Division (16-bit by 8 bit).
3. Logical Instructions: 8x8 multiplication using shift Add technique. ASCII to packed BCDand vice versa. Exchange 2 numbers without the use of 3rd location. Implementation of Boolean expressions (Bit Manipulation).
4. Timers: Wave form generation with varying Duty Cycle using Interrupt andPollingTechniques.
5. Serial Communication: Serial data transmission with Polling and Interrupt technique(Regular and Look up table).

Section-B (Embedded C Programming)

6. Serial Reception and Display the ASCII value of Key pressed on LCD.
7. Count the incomingpulses using counters.
8. DC Motor speed control using external interrupt.
9. Stepper motor interfacing by controlling the steps and direction.
10. Interfacing DAC to generate various waveforms with output voltage varying between-12Vto 12V with Amplitude and Frequency control.
11. Keyboard Interfacing.

Course outcomes:

After completion of the course a student shallbe able to:

1. Solve basic binary math operations using the microcontroller.
2. Demonstrate programming proficiency using the various addressing modes and data transferinstructions of the target microcontroller.
3. Program using the capabilities of the stack, the program counter, and the status register andshow how these are used to execute a machine code program.
4. Develop industrial applications and requirements.
5. Interface various peripherals.

Text Books:

1. Kenneth J. Ayala, "The 8051-microcontroller architecture, programming andapplications"Thomson publication, 3rd edition, 2007
2. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D, McKinlay "The 8051 Microcontroller and Embedded Systems using assembly and C"PHI, 2006/Pearson 2006.

Reference Books:

1. V. Udayashankar and Malikarjunswamy, "The 8051 Microcontroller", TMH, 2009.
2. Raj Kamal,"Microcontrollers: Architecture, Programming, Interfacing and System Design",Pearson Education, 2005.

COURSE NAME: FLUID MECHANICS & FLUID MACHINES					
COURSE CODE :ME433P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

To learn about the application of mass and momentum conservation laws for fluid flows

To understand the importance of dimensional analysis

To obtain the velocity and pressure variations in various types of simple flows

To analyse the flow in water pumps and turbines.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1 Introduction to Fluid Mechanics and Statics	
Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension,capillarity, vapour pressure, compressibility and bulk modulus. Pascal's law, Absolute, gauge, atmospheric and vacuum pressures. Pressure measurement by simple, differential manometers and mechanical gauges. **Fluid Statics:** Buoyancy, center of buoyancy, meta center and meta centric height its application in shipping, stability of floating bodies.	**9**
Unit-2 Fluid Kinematics and Dynamics	
Fluid Kinematics: Types of Flow-steady , unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. **Fluid Dynamics:** Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturi meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals.	**9**
Unit-3Major and Minor losses in Pipes	
Major and Minor losses in Pipes: Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, Chezy's equation, Darcy Weishach formula, major and minor losses in pipes, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe, Related Numericals and simple pipe design problems.	**9**
Unit-4Flow Over Bodies& Dimensional Analysis	
Flow Over Bodies: Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift, streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil, Numerical problems.	**9**

Dimensional Analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Numerical problems.	
Unit-5Compressible Flows& CFD	
Compressible Flows: Introduction, thermodynamic relations of perfect gases, internal energy and enthalpy, speed of sound, pressure field due to a moving source, basic Equations for one-dimensional flow, stagnation and sonic Properties, normal and oblique shocks. **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, and applications.	**9**
List of Experiments {If any}:	**Practical Hours**
1. Determination of coefficient of friction of flow in a pipe.	**3**
2. Determination of minor losses in flow through pipes	**3**
3. Determination of force developed by impact of jets on vanes.	**3**
4. Determination of coefficient of discharge of a Orifice plate meter.	**3**
5. Determination of coefficient of discharge of a Venturimeter.	**3**
6. Determination of coefficient of discharge of a V-notch.	**3**
7. Determination of Drag and Lift coefficient of a submerged body	**3**
8. Determination of Metacenter and Metacentric height of a floating body	**3**
9. Determination of Pressure drop inside a duct/pipe through principle of Bernoullis Theorem	**3**
Self-study : Nil	
Site/Industrial Visits : Nil	
Course outcomes: **CO1:**Explain pressure measurement by simple and differential manometer using Pascals law, and explain viscosity, surface tension and capillarity by comprehending the properties of fluids. {L3} **CO2:**Determine metacentric height using conditions of equilibrium, and explain stream function, potential function and vorticity using basic concepts of inviscid flow. {L3} **CO3:**Execute derivation of Bernoulli's equation from Euler's equation, and explain flow rate measurement using venturimeter, orifice meter, pitot tube, and V and rectangular notches. {L3} **CO4:**Determine dimensionless groups for fluid flow analysis through Buckingham pi theorem and Rayleigh's method, and explain direct measurements, analogue methods, flow visualization and components of measuring systems by comprehending concepts of experimental fluid mechanics. {L3} **CO5:**Calculate pressure drop in pipe flow, and drag and lift coefficients in external flow using experimental relations, and determine Mach number by comprehending basic concepts of compressible flow. {L3}	

Text Books: **T1.** Bansal. R.K, "Fluid Mechanics and Hydraulics Machines", 9th edition, Laxmipublications {P} Ltd., New Delhi,2017 **T2.** Yunus A Cengel & John M. Cimbala, Fluid Mechanics, Tata McGraw Hill Edition New Delhi, 2013
Reference Books: **R1.** White. F.M, "Fluid Mechanics", Tata McGraw-Hill, 8th Edition, New Delhi, 2016 **R2.** Streeter V.L., Benjamin Wylie, "Fluid Mechanics", Mc Graw Hill Book Co., New Delhi,1999 **R3.** Robert W. Fax, Philip J. Pritchard, Alan T. McDonald, "Introduction to Fluid Mechanics", Wiley India Edition {Wiley Student Edition 8th 2014} **R4.** Modi P.N, & Seth S.M, "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 14th edition, 2002 **R5.** Shiv Kumar, "Fluid Mechanics & Fluid Machines: Basic Concepts & Principles", Ane Books Pvt. Ltd., New Delhi, 2010
Online Resources: **W1.** https://nptel.ac.in/courses/105101082/ **W2.** https://lecturenotes.in/subject/240/fluid-mechanics-fm

COURSE NAME: MANUFACTURING PROCESSES					
COURSE CODE :RM434P					
	L	**T**	**P**	Category	**ESC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

1. To provide a basic knowledge on manufacturing Processes and selection of the process for production.
2. To provide a basic knowledge about the casting process casting defects, melting furnaces, moulding techniques.
3. To gain sound knowledge about welding process and its application in fabrication areas.
4. To provide basic knowledge about various machining processes and their applications e.g. Lathe, Drilling, Milling, Grinding etc.

Prerequisites:

Basic Knowledge of Engineering Mathematics, Physics and Chemistry.
ME135/235: Basic Mechanical Engineering and Nanoscience.

Units	**Teaching Hours**
Unit-1: Metal Casting and Joining Process	
Metal Casting: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. **Joining/Fastening Processes:** Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.	**10**
Unit-2: Metal Cutting Processes	
Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.	**8**
Unit-3: Metal Forming and Additive Manufacturing	
Metal Forming: Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming{forging, rolling, extrusion, drawing} and sheet forming {shearing, deep drawing, bending} principles of powder metallurgy. **Additive Manufacturing:** Rapid prototyping and rapid tooling.	**7**
Unit-4: Mechanical and Electro-Thermal Energy Processes	
Mechanical Energy: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters. **Electro-Thermal Energy:** Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM.	**9**
Unit-5: Electro-Chemical Energy and Newer Machining Processes	

Electro-chemical Process: Electro-chemical machining {ECM}, etchant & maskant, process parameters, MRR and surface finish. **Newer Machining Processes**: Laser Beam Machining {LBM}, Plasma Arc Machining {PAM} and Electron Beam Machining {EBM}**.**	**11**
List of Experiments	**Practical Hours**
Introduction about machine tools	2
Plain turning and Simple Facing	4
Chamfering and Centering	2
Step turning and Taper turning	4
Knurling and Thread cutting	4
Shaping rectangular block or cube	4
Slot cutting / Step-cutting / V-block	4
Spur gear cutting	4
Surface grinding	2
Total	**30**

Self-study :
Unit-1: Gating system and core making.
Unit-2: Cutting tool materials.
Unit-3: Tube drawing processes.
Unit-4: Types of dielectric fluids and their characteristics.
Unit-5: Chemical machining and their applications.

Site/Industrial Visits :
1. Forging and foundry Lab.
2. Any Manufacturing/ production plant {on prior permission from concerned industry}.
3. Metal Cutting Lab.

Course outcomes:
The students will be able to
CO1: Enumerate the basic steps involved in casting process, their Applications and also describe various types of joining processes and select the appropriate one according to the application. [L1, L2, L3] [PO1, PO2, PO3].
CO2: Illustrate the basic principle of working of machine tools viz. Lathe, Milling, Grinding, Drilling machines etc. [L1, L2] [PO1, PO2].
CO3: Distinguish the hot working and cold working processes and discuss the various metal forming processes and also elaborate their applications. [L3, L4] [PO1, PO2, PO3, PO4].
CO4: Explain the concept of additive manufacturing and list their areas of application. [L1, L3] [PO1, PO2, PO3].
CO5: Classify and summarize the unconventional machining processes. [L2, L3] [PO1, PO2, PO3].

Text Books:
T1. J. P. Kaushish, "Manufacturing Processes", 2nd Edition, Prentice-Hall of India Pvt. Ltd; 2010, ISBN-13: 978-8120340824.

T2. P. N. Rao, "Manufacturing Technology: Foundry, Forming and Welding", 4th Edition Volume 1, McGraw Hill Publications, 2013.
T3. Dr. K. Radhakrishna "Manufacturing process 1 {Casting & Welding process}" 8th Edition. Sudha publications, 2010.
T4. P C Pandey and H s Shan, "Modern Machining Processes", Tata Mcgraw-Hill Publications, 1993.
T5. Hajra Choudhury S K, "Elements of Workshop Technology" 13th Edition, Volume 2, Machine Tools, India Book Distributing Company Calcutta, 2010, ISBN-8185099154. 97881850991565.
T6. Milton C. Shaw, "Metal Cutting Principles", 2nd Edition, Oxford University Press, 2008.

Reference Books:

R1. Steven R Schmid and Serope Kalpak Jain, "Manufacturing Engineering and Technology", Pearson Publications, 2001.
R2. Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", 3rd Edition, CRC Press, 1988, ISBN: 0824778529, 9780824778521.
R3. R K Jain, "Production Technology: Manufacturing Processes, Technology and Automation" 17th Edition, Khanna Publishers, 2002.

Online Resources:

W1. http://nptel.ac.in/courses/ noc18_me51

COURSE NAME: PROFESSIONAL ETHICS					
COURSE CODE :HS435					
	L	**T**	**P**	Category	**HSMC**
Contact Hrs./Week	**2**	**0**	**0**	CIA Marks	**25**
Contact Hrs./Sem.	**30**	**0**	**0**	ESE Marks	**25**
Credits.	**2**	**0**	**0**	Exam Hours	**2**

Course objectives: This paper deals with the various organizational behaviours like learning, perception, motivation and method of managing stress and conflicts and the basic principles of communication.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1 : Introduction	
Definition of Organization Behaviour and Historical development, Environmental context {Information Technology and Globalization, Diversity and Ethics, Design and Cultural, Reward Systems}. THE INDIVIDUAL: Foundations of individual behaviour, individual differences. Ability. Attitude, Aptitude, interests. Values.	**6**
Unit-2: Learning and Perception	
Learning: Definition, Theories of Learning, Individual Decision Making, classical conditioning, operant conditioning, social learning theory, continuous and intermittent reinforcement. PERCEPTION: Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect.	**6**
Unit-3 : Motivation & The Groups	
Motivation: Maslow's Hierarchy of Needs theory, Mc-Gregor's theory X and Y, Hertzberg's motivation Hygiene theory, David Mc-Clelland's three needs theory, Victor Vroom's expectancy theory of motivation**.** THE GROUPS: Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, group processes, group tasks, group decision making.	**6**
Unit-4: Conflict & Stress Management	
Definition of conflict, functional and dysfunctional conflict, stages of conflict process. Sources of stress, fatigue and its impact on productivity.Job satisfaction, job rotation, enrichment, job enlargement and reengineering work process.	**6**
Unit-5: Principle of Communication	
Useful definitions, communication principles, communication system, role of communication in management, barriers in communication, how to overcome the barriers, rule of effective communication.	**6**
Self-study : Nil	

Site/Industrial Visits : Nil
Course outcomes: CO1: To communicate in an effective manner in an organization. {Level-1, PO-1} CO2:To motivate the team members in an organization. {Level-3, PO-2} CO3: To Study the various motivational theories {Level-2, PO-3} CO4:To study the various methods of learning. {Level-1, PO-2} CO5:To effectively manage the stress and conflicts in an organization.{Level-1, PO-1}
Text Books: T1. Organizational Behaviour, Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002 T2: Organizational Behaviour, Fred Luthans, 9th Edition, Mc Graw Hill International Edition, ISBN-0-07-120412-12002
Reference Books: R1.Organizational Behaviour, Hellriegel, Srocum and Woodman, Thompson Learning, 9th Edition, Prentice Hall India, 2001 R2.Organizational Behaviour, Aswathappa - Himalaya Publishers. 2001 R3.Organizational Behaviour, VSP Rao and others, Konark Publishers.2002 R4.Organizational Behaviour, {Human behaviour at work} 9th Edition, John Newstron/ Keith Davis. 2002
Online Resources: W1. Nil

COURSE NAME: COMPUTER AIDED MACHINE DRAWING					
COURSE CODE : ME436					
	L	**T**	**P**	Category	**ESC**
Contact Hrs./Week	**2**	**0**	**2**	CIA Marks	**50**
Contact Hrs./Sem.	**30**	**0**	**15**	ESE Marks	**50**
Credits.	**2**	**0**	**1**	Exam Hours	**3**

Course objectives:

Machine Drawing is a language between the engineers, to communicate the technical information required for the manufacturing. This course deals with orthographic projection, fasteners, joints and couplings, and assembly drawings of machine parts. Review of basic sketching, parts, assembly and drawing commands in the software.

Prerequisites: Engineering Graphics

Units	**Teaching Hours**
Unit-1 Introduction	
Introduction to GD&T: Introduction to dimensional analysis, GD&T and its tools, Datum's and concepts, manufacturing GD&T and its application, application of GD&T and its Principles. **Orthographic Views:** Conversion of pictorial views into orthographic projections of Sectional view of machine parts. {Bureau of Indian Standards conventions are to be followed for the drawings} Hidden line conventions. Precedence of lines.	**8**
Unit-2 Threads & Fasteners	
Thread Forms: Thread terminology, sectional views of threads. ISO Metric {Internal & External} BSW {Internal & External} square and Acme. Sellers thread, American Standard thread. **Fasteners:** Hexagonal headed bolt and nut with washer {assembly}, square headed bolt and nut with washer {assembly} simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.	**8**
Unit-3 Riveted Joints and Couplings	
Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps {Chain and Zigzag, using snap head rivets}. Cotter joint {socket and spigot}, knuckle joint {pin joint} for two rods. **Couplings:** Split Muff coupling, Protected type flanged coupling, pin {bush} type flexible coupling, Oldham's coupling and universal coupling {Hooks' Joint}	**8**
Unit-4Surfacing	
Surfacing: Introduction to surfacing, Hands on surface Modeling. Sheet Metal: Introduction to Sheet Metal, Modeling of sheet metal component.	**8**
Unit-5Assembly Drawings	

Assembly Drawings {Part drawings should be given} 1. Plummer block {Pedestal Bearing} 2. Rams Bottom Safety Valve 3. I.C. Engine connecting rod 4. Drill Jig 5. Tailstock of lathe 6. Machine vice 7. Crane Hook	**13**
Self-study : Nil	
Site/Industrial Visits : Nil	
Course outcomes: CO1: {Students will be able to understand the concept and importance of limits fits and tolerance in the manufacturing drawing. } {L1,L2} {PO1,PO2} CO2 :{ Students will be able to understand the thread terminologies, different types of fasteners, keys and joints and couplings used in machine parts. }{L1,L2,L5}{PO1,PO2,PO5} CO3 :{ Student will be able to perform both 2D to 3D drawings of any components using the modeling software.}{ L1,L5}{PO1,PO5} CO4 :{ Students will be able to visualize and model different parts of a machine.}{L1,L5}{PO1,PO5} CO5:{ Students will be able to construct assemblies and drawing of various machines like screw jack, machine vice, tail stock of lathe from the concepts learnt using the modeling software.}{ L1,L2,L5}{PO1,PO2,PO5}	
Text Books: T1. Machine Drawing by K L Narayana, P Kannaiah & K Venkata Reddy, 5th edition, new age International Publishers 2016. T2. N.D.Bhat & V.M.Panchal,'A Primer on Computer Aided Machine Drawing-2007',VTU, Belgaum, 'Machine Drawing', 2012.	
Reference Books: R1. S. Trymbaka Murthy,'A Text Book of Computer Aided Machine Drawing',CBS Publishers, New Delhi, 2007 R2. K.R. Gopala Krishna,'Machine Drawing', Subhash Publication,2012. R3. Goutam Pohit & Goutham Ghosh,'Machine Drawing with Auto CAD',1st Indian print Pearson Education, 2007 R4. Auto CAD 2015, for engineers and designers', Sham Tickoo. Dream tech 2015 R5. Machine Drawing', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata Mc GrawHill,2006 R6. Alex Krulikowski,"Fundamentals of Geometric Dimension & Tolerancing",6 edition , Goodheart-Willcox Pub ,25 November 2014	
Online Resources: W1. http://www.nptelvideos.in/2012/12/computer-aided-engineering-design.html	

COURSE NAME: CYBER SECURITY					
COURSE CODE : MC					
	L	**T**	**P**	Category	**MC**
Contact Hrs./Week	**2**	**0**	**0**	CIA Marks	**0**
Contact Hrs./Sem.	**30**	**0**	**0**	ESE Marks	**0**
Credits.	**0**	**0**	**0**	Exam Hours	**0**

Course objectives:
Providing knowledge about different Cyber Crimes, Threats and Laws .Creating awareness about risk management and protection from the cyber threats.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Security Fundamentals-4 As Architecture Authentication Authorization Accountability, Social Media, Social Networking and Cyber Security. Cyber Laws, IT Act 2000-IT Act 2008-Laws for Cyber-Security, Comprehensive National Cyber-Security Initiative CNCI – Legalities.	**6**
Unit-2	
Cyber Attack and Cyber ServicesComputer Virus – Computer Worms – Trojan horse.Vulnerabilities - Phishing - Online Attacks – Pharming - Phoarging – Cyber Attacks - Cyber Threats - Zombie- stuxnet - Denial of Service Vulnerabilities - Server Hardening-TCP/IP attack-SYN Flood.	**6**
Unit-3	
Cyber Security Management Risk Management and Assessment - Risk Management Process - Threat Determination Process -Risk Assessment - Risk Management Lifecycle.Security Policy Management - Security Policies - Coverage Matrix Business Continuity Planning - Disaster Types - Disaster Recovery Plan - Business Continuity Planning Process.	**6**
Unit-4	
Vulnerability - Assessment and Tools: Vulnerability Testing - Penetration Testing Black box- white box. Architectural Integration: Security Zones - Devicesviz Routers, Firewalls, DMZ. Configuration Management - Certification and Accreditation for Cyber-Security.	**6**
Unit-5	
Authentication and Cryptography: Authentication - Cryptosystems - Certificate Services Securing Communications: Securing Services - Transport – Wireless - Steganography and NTFS D ata Streams. Intrusion Detection and Prevention Systems: Intrusion - Defense in Depth - IDS/IPS - IDS/IPS Weakness and Forensic Analysis Cyber Evolution: Cyber Organization - Cyber Future	**6**

Self-study : Nil

Site/Industrial Visits : Nil

Course outcomes:

CO1: Explain the concepts associated to Indian Information Technology Act 2000 and 2008 {L2}
CO2: Illustrate the need for Security and outline Threats, Attacks and Legal issues. {L2}
CO3: Experiment with various Risk, Vulnerable and Possible Controls {L3}
CO4: Understand the Policies, Standards and Practices of Information Security {L2}
CO5: Examine the IDS, Scanning, Tools and Access Control Devices in connection with authentication and cryptography. {L4}

Text Books:

1. Jennifer L. Bayuk and Jason Healey and Paul Rohmeyer and Marcus Sachs, Cyber Security Policy Guidebook, Wiley; 1 edition , 2012, ISBN-10: 1118027809
2. Dan Shoemaker and Wm. Arthur Conklin, Cybersecurity: The Essential Body Of Knowledge, Delmar Cengage Learning; 1 edition (May 17, 2011) ,ISBN-10: 1435481690
3. Jason Andress, The Basics of Information Security: Understanding the Fundamentals of InfoSec in Theory and Practice, Syngress; 1 edition (June 24, 2011) , ISBN-10: 1597496537
4. Stallings, "Cryptography & Network Security - Principles & Practice", Prentice Hall, 3rd Edition 2002.
5. Bruce, Schneier, "Applied Cryptography", 2nd Edition, Toha Wiley & Sons, 2007.
6. Man Young Rhee, "Internet Security", Wiley, 2003.
7. Pfleeger & Pfleeger, "Security in Computing", Pearson Education, 3rd Edition, 2003.

2014.

Reference Books:

1. Matt Bishop, "Computer Security Art and Science", Pearson/PHI, 2009.
2. Stuart Mc Clure, Joel Scrambray, George Kurtz, "Hacking Exposed", 7th Edition Tata McGraw-Hill, 2012.Hall, 2014.

Online Resources:

1. https://www.aicte-india.org/downloads/itact2000.pdf
2. Von Solms, Rossouw, and Johan Van Niekerk. "From information security to cyber security." computers & security38 (2013): 97-102.
3. Ahmad, Nazilah, et al. "Cyber Security Situational Awareness among Parents." 2018 Cyber Resilience Conference (CRC). IEEE, 2018.
4. Bhusan, Mayank, Rajkumar Singh Rathore, and Aatif Jamshed. Fundamental of Cyber Security. BPB Publications, 2018.
5. Klingensmith, Kurt, and Azad M. Madni. "Architecting Cyber-Secure, Resilient System-of-Systems." Disciplinary Convergence in Systems Engineering Research. Springer, Cham, 2018. 157-174.

V SEMESTER

COURSE NAME: DATA ACQUISITION SYSTEMS					
COURSE CODE :RM531P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**15**	ESE Marks	**50**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

- To deal with basics concepts for selection of sensors and the signal conditioning necessary to include these in a data acquisition system.
- To investigate the analogue to digital and digital to analogue conversion principles and their practical applications for data acquisition and control.
- To learn about the selection of output drivers and devices

Prerequisites:

Units	**Teaching Hours**
Unit-1	
Introduction: General Measurement System, Static and Dynamic characteristics of instruments – qualitative study, Loading effects, Signals and noise in Measurement Systems, Reliability, Choice and economics of Measurement systems.	**9**
Unit-2	
Sensing Elements: Equivalent circuit of Resistive, capacitive, inductive, electromagnetic, thermoelectric, elastic, piezoelectric, piezoresistive, electrochemical sensing elements, Hall effect sensors, characteristics	**9**
Unit-3	
Signal conditioning: Amplification, Impedance Matching, Instrumentation Amplifiers, Charge Amplifiers, Filtering, attenuation, Noise Reduction and Isolation – Grounding Conflict, Ground Loops, Cross Talk, Shielded Wiring, Isolation, Linearization, Circuit protection.	**9**
Unit-4	
Interfacing circuits: Digital I/O interfacing, Microprocessor interfacing, serial interfaces, multi-channel ADCs, internal microcontroller ADCs, ADC specifications, resolution, accuracy, linearity, offset and quantization errors, sample rate and aliasing, Codecs, line drivers and receivers, high power output drivers and devices.	**9**
Unit-5	
Data Acquisition Systems: Parameters of Data Acquisition Systems such as dynamic range, calibration, bandwidth, processor throughput, time-based measurements and jitter-Transducer Electronic data sheet, Smart Sensors, System Architecture, Case Studies	**9**
Laboratory Work: Op-amp as a comparator and its application, Integrator and differentiator, Active filters, Simulation	

of the above applications using ORCAD, Instrumentation Amplifier/AD 620, Interfacing of sensors and transducers using DAQ cards.
Site/Industrial Visits : NA
Course outcomes: CO1: Understand the basics of measurement system and its characteristics. (L1, L2)(PO1) CO2:Represent the equivalent circuit of sensors and describe their significant properties (L1, L2). (PO1, PO2). CO3:Choose the type of signal conditioning circuits to be used for a specific sensor.(L1, L2, L3). (PO1, PO2, PO3). CO4:Discuss the data conversion circuits and the constraints involved in their design.(L1, L2, L3). (PO1, PO2, PO3). CO5:Examine the requirements for interfacing circuit design.(L1, L2, L3). (PO1, PO2, PO3). CO6:Develop simple working model of a complete data acquisition system.(L1, L2). (PO1, PO2).
Text Books: T1. Bentley, John P. Principles of Measurement Systems, 4:th edition, Pearson/Prentice Hall, 2005.
Reference Books: R1.1. Jacob Fraden, Handbook of Modern Sensors – Physics, Design and Applications, Fourth Edition, Springer, 2010. R2. 2. Data Acquistion Handbook, A Reference for DAQ and analog and digital signal conditioning, 3rd Edition, 2012.
Online Resources: W1.https://nptel.ac.in/

COURSE NAME: DESIGN OF MACHINE ELEMENTS					
COURSE CODE :RM533					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- The student shall gain appreciation and understanding of the design function in mechanical engineering, the steps involved in designing and the relation of design activity with manufacturing activity.
- Shall be able to choose proper materials to different machine elements depending on their physical and mechanical properties. Thus he shall be able to apply the knowledge of material science in real life usage.
- Student shall gain a thorough understanding of the different types of failure modes and criteria. He will be conversant with various failure theories and be able to judge which criterion is to be applied in which situation.
- Student shall gain design knowledge of the different types of elements used in the machine design process. E.g., fasteners, shafts, couplings etc. and will be able to design these elements for each application.

Prerequisites: Basic knowledge on strength of materials

Units	**Teaching Hours**
Unit-1	
Definitions: normal, shear, biaxial and tri axial stresses, Stress tensor, Principal Stresses. Engineering Materials and their mechanical properties, Stress-Strain diagrams, Stress Analysis, Design considerations: Codes and Standards.	**9**
Unit-2	
Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, Distortion energy theory. Failure of brittle and ductile materials, Stress concentration, Determination of Stress concentration factor. **Impact Strength:** Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. **Design For Fatigue Strength:** Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.	**9**
Unit-3	
Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links **Cylinders & Cylinder Heads:** Review of Lame's Equations; compound cylinders, stresses due to different types of fits, cylinder heads, flats.	**9**
Unit-4	

Design Of Springs: Types of springs - stresses in Helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads, Leaf Springs: Stresses in leaf springs. Equalized stresses, Energy stored in springs, Torsion, Belleville and Rubber springs.	**9**
Unit-5	
Riveted and Welded Joints – Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozanze Joints, Riveted Brackets. Welded Joints – Types, Strength of butt and fillet welds, eccentrically loaded welded joints. **Threaded Fasteners:** Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static, dynamic and impact loads, Design of eccentrically loaded bolted joints.	**9**
Self-study : NA	
Site/Industrial Visits : NA	
Course outcomes: CO1: Discuss the function of machine elements in mechanical engineering, the steps involved in designing and the relation of design activity with manufacturing activity.(L1, L2)(PO1) CO2:Analyze the different types of failure modes and will be conversant with various failure theories and be able to judge which criterion is to be applied in which situation. (L1, L2). (PO1, PO2). CO3:Apply the knowledge of the curved beams and cylinders in determining the stresses developed for its real time usage. (L1, L2, L3). (PO1, PO2, PO3). CO4:Select the type of spring required for the application and will be able to calculate dimensions of spring. (L1, L2, L3). (PO1, PO2, PO3). CO5:Design the different types of elements used in the machine design process. Eg. Riveted joint, Welded Joints etc. and will be able to design these elements for each application. (L1, L2, L3). (PO1, PO2, PO3). CO6:Demonstrate the use standard practices in design of machine elements and standard data. (L1, L2). (PO1, PO2).	
Text Books: T1. Design of Machine Elements 1, K Raghavendra, CBS Publishers and Distributors Private Limited, New Delhi, 1nd Edition 2017. T2. Design of Machine Elements 2, K Raghavendra, CBS Publishers and Distributors Private Limited, New Delhi, 1nd Edition 2015. T3. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke, McGraw Hill International edition, 6th Edition 2009. T4. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition first reprint 2010.	
Reference Books: R1.Robert L. Norton, "Machine Design", 3rd Impression, Pearson Education Asia, 2008. R2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, "Design of Machine Elements", Special Indian Edition, Pearson Education, 2006. R3. Hall, Holowenko, Laughlin, "Machine Design", Special Indian Edition, Schaum's Outlines series, Tata McGraw Hill Publishing Company Ltd., 2010. R4. Robert C. Juvinall and Kurt M Marshek, "Fundamentals of Machine Component Design", 5th Edition, Wiley India Pvt. Ltd., 2012. **DESIGN DATA HANDBOOKS:** 1. K. Lingaiah, "Design Data Hand Book", 4th edition, McGraw Hill, 2013.	

2. K. Mahadevan and Balaveera Reddy, "Design Data Hand Book", 4th edition, CBS Publication, 2013.
3. H.G. Patil, Shri ShashiPrakashan, "Design Data Hand Book", Belgaum. Reprint, I K International Publishing house, 2011

Online Resources:
W1.https://nptel.ac.in/

COURSE NAME: ELECTRICAL MACHINES AND DRIVES					
COURSE CODE : HS 536					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**15**	ESE Marks	**50**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

- To impart knowledge on the performance characteristics, speed control and starting methods of DC and AC motors.
- To impart knowledge on the basic of selection of drive for a given application.
- To impart knowledge on the concept of controlling the speed of DC and AC motor using Solid state converters.
- To prepare the students to understand, demonstrate and analyze the concepts of DC and AC Motors.
- To prepare the students to understand, demonstrate and analyze the concepts of DC Drive.
- To prepare the students to understand, demonstrate and analyze the concepts of AC Drive.

Prerequisites: Basic knowledge on electrical and electronics engineering

Units	**Teaching Hours**
Unit-1:Electric Motors	
Constructional details – Principle of operation – Performance characteristics of DC Motor, Single Phase Induction Motor, Three Phase Induction Motor, Synchronous Motor, Universal Motor, Stepper Motors and Reluctance Motors	10
Unit-2: Speed Control and Starting	
Speed control of D.C. motors – Ward – Leonard system – Electrical Braking – Starting methods - Three phase induction motors – Starting methods – Electrical braking – Speed Control methods – Slip Power Recovery Scheme	**8**
Unit-3: Electric Drives	
Types of Electrical Drives – Selection & factors influencing the selection – heating and cooling curves – loading condition – Classes of duty – determination of Power rating – Load equalization	**6**
Unit-4: Power Semiconductor Devices and Converters and Inverters	
Basic structure and operation of SCR, static and dynamic switching characteristics – MOSFET - general switching characteristics - IGBT - static and dynamic switching characteristics.	**11**

Introduction - Controlled Converters – two pulse converter - three pulse converter – Chopper – Types of Chopper – Inverter – Voltage Source Inverter – Current Source Inverter – Cycloconverter	
Unit-5: Solid State Speed Control	
Advantages of Solid State Control - Control of DC Drives using Converters – Choppers – Control of Three Phase Induction Motors using Stator Voltage Control – V/F Control and Slip Power Recovery Schemes using Inverters and AC power regulators.	**10**

Lab:-

The laboratory will demonstrate the student about the operation and control of DC and AC Motor with Solid state converters.

List of Experiments (Any Eight from the list)

1. Speed Control of DC Shunt Motor
2. Speed Control of Three Phase Squirrel Cage Induction Motor
3. Speed Control of Three Phase Slip Ring Induction Motor
4. Switching Characteristics of Power Semiconductor Devices (SCR, MOSFET, IGBT)
5. Chopper Fed DC Drive
6. Three Phase Converter Fed DC Drive
7. Control of Induction Motor with AC Voltage Regulator
8. Voltage Control of Voltage Source Inverter Fed AC Drive
9. V/F control of AC Drive
10. Cycloconverter Fed Synchronous Motor Drive

Site/Industrial Visits :

NIL

Course outcomes:

The students will be able to

CO1: Explain the various method of speed control of DC and AC motors L1)(PO1,PO2)

CO2:Describe the factors for selection of drive, various load pattern and determine their power rating.(L1,L2) (PO1,PO2)

CO3: Discuss the working of various power semiconductor devices. (L1,L2)(PO1,PO2)

CO4:Demonstrate the working of various power converters and inverters (L1,L2) (PO1,PO2)

CO5: Apply and Analyze the control of DC and AC motors with solid state power converters and inverters. (L1,L2) (PO1,PO2,PO5,PO7)

CO6: Conduct the suitable method for speed control of DC and AC motors. (L1,L2) (PO1,PO2,PO4)

Text Books:

T1. Gopal K. Dubey, "Fundamentals of Electric Drives", Narosa Publications, New Delhi, 2nd Edition, 2002.

T2. Kothari D.P., Nagrath I.J., "Electrical Machines", Tata McGraw Hill Education India Private Limited, New Delhi, 3rd Edition, 2004.

T3. VedamSubrahmanyam, "Electric Drives: Concept and Application", Tata McGraw-Hill Education, 2nd Edition, 2011.

Reference Books:

R1. Sen P.C., "Principles of Electrical Machines and Power Electronics", John Wiley Publications Private Limited, 3rd Edition, 2013.

R2. Pillai S.K., "A First course on Electrical Drives", New Age International Private Limited, New Delhi, 1991.

R3. Bhattacharya, "Electrical Machines", Tata McGraw Hill Education, 2008.

Online Resources:

W1. https://nptel.ac.in/courses/108104140/

COURSE NAME: ANALYSIS LABORATORY					
COURSE CODE :RM 552					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**0**	**0**	**2**	CIA Marks	**25**
Contact Hrs./Sem.	**0**	**0**	**30**	ESE Marks	**25**
Credits.	**0**	**0**	**2**	Exam Hours	**2**

Course objectives:

- Simulation is used intensively in a field of design and development.
- Students will understand how to prepare the basic model and how to perform simulation on it by taking various assumption.
- Students can apply the knowledge they have obtained while studying FEM and Mechanical Vibration.

Prerequisites: FEM

List of Experiments (If any):	**Practical Hours**
1. Stress analysis of a plate with circular hole	**2**
2. Stress analysis of rectangular l bracket	**2**
3. Stress analysis of beam	**2**
4. Mode frequency analysis of beam	**2**
5. Harmonic analysis of a 2d component	**2**
6. Eigenvalue Buckling of a Square Tube	**2**
7. Stress analysis of an axisymmetric component	**2**
8. Thermal stress analysis of a 2d component	**2**
9. Non-linear Analysis of Skew Plate	**4**
10. Buckling of a Square Tube with Imperfections	**4**
11. Hinge Model	**3**
12. Non-linear Analysis of Skew Plate	**3**

Self-study : NA

Site/Industrial Visits :NA

Course outcomes:

CO 1: Applying the boundary conditions on the given system.(L2)(PO1,PO2,PO3)

Co2: Solving Engineering Mechanics Problems by using Commercial FEM Tools. (L3, L4, L5) (PO1,PO2,PO3)

Reference Books:

R1. M. Asghar Bhatti, "FUNDAMENTAL Finite Element Analysis and Applications with Mathematica and MATLAB Computations", Wiley India Pvt. Ltd.
R2.Stormy Attaway, "Matlab: A Practical Introduction to Programming and Problem Solving", 3rd edition, Butterworth-Heinemann Publisher.
R3.W. Y. Yang and W. C. T.-S. Chung., Applied Numerical Methods Using Matlab, John Wiley & Sons, Inc., 2005
R4.S. J. Chapman, MATLAB programming for engineers, New Delhi: Cengage Learning, 2004
R5.K. B. Datta, Matrix And Linear Algebra Aided with Matlab, New Delhi: PHI Learning Private Limited, 2009
R6.M. P. Coleman, An introduction to partial differential equations with MATLAB, Boca Raton: CRC Press, 2005

Online Resources:

W1.https://nptel.ac.in/

VI SEMESTER

COURSE NAME: CNC TECHNOLOGY					
COURSE CODE : RM631P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	3	0	2	CIA Marks	**50**
Contact Hrs./Sem.	45	0	30	ESE Marks	**50**
Credits.	3	0	1	Exam Hours	**3**

Course objectives:

• The objective is to give an overview of the CNC systems. Various classification of CNC machines and their selection criteria. Constructional features of these machines along with the description of control system. Creating part programming to execute in CNC machines and the maintenance and repair of these CNC machines.

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1	
Fundamentals of process planning and CNC systems: Introduction to Computer Numerical Control: CNC Systems – An Overview of Fundamental aspects of machine control, Different types of CNC machines – Advantages and disadvantages of CNC machines. Process planning, Structure of process plan, factors influencing process plan, Sequence of operation of process, CAM, NC, CNC and DNC, selection criteria for CNC machines, adaptive control	**9**
Unit-2	
Constructional features of CNC machines: Classifications of CNC Machine, modes of operation of CNC, working of: Machine Structure, Slide ways, Spindle drive, Axis drive, Recirculating ball screw Feedback devices (transducers, encoders), Automatic tool changer (ATC), Automatic pallet changer (APC), SMED Technique, CNC axis and motion nomenclature, CNC tooling – tool pre-setting, qualified tool, tool holders and inserts.	**9**
Unit-3	
Description of a simple CNC control system. Interpolation systems. Features available in a CNC system – introduction to some widely used CNC control systems. Types of measuring systems in CNC machines – Incremental and absolute rotary encoders, linear scale – resolver – Linear inductors – Magnetic Sensors for Spindle Orientation. Qualified and pre-set tooling – Principles of location – Principles of clamping – Work holding devices.	**9**

Unit-4	
CNC part programming: Axis Identification in CNC turning and machining centers, machine zero, home position, work piece zero, NC Programming format, types and methods of part Programme, ISO G and M codes for turning and milling-meaning and applications of important codes. Tool length compensation, pitch error compensation, Tool radius compensation, simple part programming for turning and milling (minimum four to five operations).	**9**
Unit-5	
Maintenance of CNC machine: Types of machine tools maintenance, systems and sub systems of CNC machines, CNC Maintenance practice: Tools required, daily checklist, problems related to mechanical systems, backlash, causes and precautions of electronics system.	**9**
List of Experiments (If any):	**Practical Hours**
CNC part programming using CAM packages. Simulation of Turning, Drilling, Milling operations. 3 typical simulations to be carried out using simulation packages like Master- CAM, or any equivalent software.	**30**
Self-study : NIL	
Site/Industrial Visits : NIL	

Course outcomes:

CO1: Identify different axes, machine zero, home position, systems and controls CNC machines. {L1}{PO1}

CO2: Select, mount and set cutting tools and tool holders on CNC. {l2}{PO1}

CO3: Prepare part programmes using ISO format for given simple components with and without use of macro, canned cycle and subroutine using ISO format. {L3}{PO5}

CO4: Interface software application for auto part programming. {L2} {PO5}

CO5: Relate maintenance practices for CNC machines. {L3} {PO6}

Text Books:

T1. B.S. Pabla, M. Adithan, CNC Machines, New Age International, New Delhi, 2014.

T2. Quesada, Robert, Computer Numerical Control- turning and machining centers , PHI Learning, New Delhi, 2004.

T3. Sareen, Kuldeep, CAD/CAM, S.Chand, New Delhi, 2007.

T4. S.Vishal, Introduction to NC/CNC Machines , S.K.Kataria & Sons., New Delhi,2009

T5. P.N.Rao, N.K.Tiwari, T. Kundra, Computer Aided Manufacturing, Tata McGraw Hill, New Delhi,2014.

T6. O.P.Khanna, Industrial Engineering, Dhanpat rai, New Delhi, 2012.

Reference Books:

R1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson education, Fourth Edition, 2016.

R2. S.K.Vajpayee, Principles of CIM, PHI, 1995.

R3. G.H.Amber & P. S. Amber, Anatomy of Automation, Prentice Hall, 1962.

Online Resources:

W1. https://swayam.gov.in/nd1_noc19_me46

W2. https://swayam.gov.in/nd1_noc20_me41

COURSE NAME: COMMUNICATION SYSTEMS					
COURSE CODE : RM632P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	3	0	2	CIA Marks	**50**
Contact Hrs./Sem.	45	0	30	ESE Marks	**50**
Credits.	3	0	1	Exam Hours	**3**

Course objectives:

- To study the fundamentals of different analog communication such as Amplitude modulation and demodulation, Angle modulation and demodulation, noise performance of various receivers.
- To introduce the generic concepts of digital Communication modulation to baseband, passband modulation and to discuss about the spread spectrum modulation schemes.

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1	
RANDOM PROCESS: Introduction, Mathematical definition of a Random Process, Stationary Processes, Mean, Correlation and Covariance Functions, Ergodic Processes, Transmission of a Random Process through a Linear Time Invariant filter, Power Spectral Density, Gaussian Process.	**8**
Unit-2	
AMPLITUDE MODULATION: Generation and demodulation of conventional AM, DSB-SC-AM, SSB-SC-AM, VSB Signals, Filtering of sidebands, AM transmitters – Super heterodyne receiver and AM receiver. **ANGLE MODULATION:** Angle modulation, frequency modulation, Narrowband and wideband FM, transmission bandwidth of FM signals, Generation of FM signal – Direct FM – indirect FM, Non-linear effects in FM systems, FM Broadcast receivers, FM stereo receivers.	**10**
Unit-3	
NOISE PERFORMANCE OF AM AND FM RECEIVERS: Noise in AM (conventional AM, DSB-SC-AM, SSB-SC-AM) receivers, threshold effect, Noise in FM receivers capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and de-emphasis in FM, Comparison of performance of AM and FM systems.	**8**
Unit-4	

PULSE MODULATION: Sampling process –PAM- other forms of pulse modulation –Bandwidth –Noise trade off –Quantization –PCM- Noise considerations in PCM Systems, Limitation and modification of PCM. **SPREAD SPECTRUM MODULATION:** Pseudo- noise sequences –a notion of spread spectrum – Direct sequence spread spectrum with coherent binary phase shift keying – Signal space Dimensionality and processing gain.	**10**
Unit-5	
BASEBAND PULSE TRANSMISSION: Matched Filter- Error Rate due to noise – Inter-symbol Interference- Nyquist criterion for Distortion-less Baseband Binary Transmission- Baseband M-ary PAM transmission **PASSBAND DATA TRANSMISSION:** Introduction – Pass band Transmission model- Generation, Detection, Signal space diagram, bit error probability and Power spectra of BPSK, QPSK, FSK and MSK schemes- Differential phase shift keying	**9**
List of Experiments (If any):	**Practical Hours**
Analog Communication Lab: Characteristics of AM receiver (Selectivity & Sensitivity) Amplitude modulation (Matlab) Characteristics of FM receiver (Selectivity & Sensitivity) Frequency modulation (Matlab) Noise analysis on Matlab AM in presence of noise (Matlab) AM demodulation in presence of noise (Matlab) FM in presence of noise (Matlab) FM demodulation in presence of noise (Matlab) Analog QAM/QCM using Matlab **Digital Communication Laboratory using LabVIEW and USRP:** Modulation and detection Matched filtering and pulse shaping BER performance of BPSK, QPSK, FSK and MSK in AWGN channel. Channel estimation and equalization. Error control coding: Linear Block Codes, Cyclic Codes.	**30**
Self-study : NIL	
Site/Industrial Visits : NIL	
Course outcomes: CO1. Explain the basic concepts of analog modulation schemes.{L2} {PO1} CO2. Discriminate analog modulated waveforms in time /frequency domain and contrast the different analog system based on energy and bandwidth requirement {L3}{PO2} CO3.Describe different types of noise and predict its effect on various analog communication systems {L3}{PO2}	

CO4. Understand the types of pulse modulation techniques and fundamental concept of spread spectrum modulation {L2}{PO1}
CO5. Explain passband data transmission in terms of error probability, power spectra and baseband pulse transmission, which deals with the transmission of pulse-amplitude, modulated signals in their baseband form. {L4}{PO4}

Text Books:

T1. Simon Haykin, Communication Systems, John Wiley & sons, NY, 5th Edition, 2010.
T2. J.G. Proakis, Communication Systems, 5th edition ,Tata McGraw Hills, 2008.

Reference Books:

R1. K. Sam Shanmugam, Analog & Digital Communication, John Wiley, 2006.
R2. Roddy and Coolen, Electronic communication, PHI, New Delhi, 4th Edition, 2003.
R3. Taub and Schilling, Principles of communication systems, 3rd edition TMH, New Delhi, 2007.
R4. Bruce Carlson et al, Communication systems, McGraw-Hill Int., 5th Edition, 2009.

Online Resources:

W1. https://swayam.gov.in/nd1_noc20_ee16

W2. https://swayam.gov.in/nd1_noc19_ee47

COURSE NAME: ROBOTICS AND VISION SYSTEM					
COURSE CODE : RM633P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	3	0	2	CIA Marks	**50**
Contact Hrs./Sem.	45	0	30	ESE Marks	**50**
Credits.	3	0	1	Exam Hours	**3**

Course objectives:

- To understand the basics of drives and power transmission system.
- To learn about the kinematics of robot
- To understand the basics of sensors and the different types of robotic End Effectors
- To learn about the machine vision systems and its application
- To gain information about the different types of robot programming methods.

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1	
INTRODUCTION: Basic Structure, Classification of robot and Robotic systems, laws of robotics, work space and precision of movement. Drives and control systems **-** Robot drive mechanisms- hydraulic – electric – servomotor- stepper motor - pneumatic drives. Control systems for robot.	**9**
Unit-2	
KINEMATICS OF ROBOT MANIPULATOR: Introduction to manipulator kinematics, homogeneous transformations and robot kinematics, Denavit-Hartenberg (D-H) representation, concept of forward and inverse kinematics.	**9**
Unit-3	
SENSORS AND ROBOT END EFFECTORS: Sensors in robotics -Position sensors, Velocity sensors, Acceleration Sensors, Force/Torque sensor, Touch and Tactile sensors, Proximity, Range and sniff sensors, RCC and IRCC systems, VOICE recognition and synthesizers. Robot End Effectors **-** Types of end effectors, Mechanical grippers – Types of Gripper mechanisms – Grippers force analysis, other types of Grippers – Vacuum cups – Magnetic Grippers – Adhesive Grippers, Active and passive grippers, Robot end effector interface.	**9**
Unit-4	

Machine vision: Image Sensing and Digitizing **-** Image definition, Image acquisition devices – videcon camera and digital camera, specialized lighting techniques. Digital Images - Sampling, Quantization and Encoding. Image storage. Image Processing and Analysis **-** Data reduction – digital conversion and windowing. Segmentation – Thresholding, Edge detection and Region growing. Binary Morphology and grey morphology operations. Feature Extraction, Object recognition, Depth measurement. Application of Vision systems.	**10**
Unit-5	
Robot programming: Introduction; On-line programming: Manual input, lead through programming, teach pendant programming; Off-line programming languages, Simulation.	**8**
List of Experiments (If any):	**Practical Hours**
Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, etc	**30**
Self-study : NIL	
Site/Industrial Visits : NIL	
Course outcomes: CO1. Explain the basics of robots, drives and power transmission system. {L2} {PO1} CO2. Solve and analyse kinematics of robotic manipulator. {L3}{PO1} CO3. Illustrate different sensors and robotic end effectors. {L2}{PO2} CO4. Explain the basics of machine vision and their operation.{L2}{PO1} CO5. Program robots using different programming methods. {L4}{PO5}	
Text Books: T1. S. R. Deb and S. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010. T2. Saeed B. Niku, Introduction to Robotics,Prentice Hall of India, 2nd Edtion 2001. T3. Mikell P. Groover, Industrial Robots - Technology, Programming and Applications, McGraw Hill, New York, 2008.	
Reference Books: R1**.** Richard D Klafter, Thomas A Chmielewski, Michael Negin, Robotics Engineering – An Integrated Approach, Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.	

R2. Fu K S, Gonzalez R C, Lee C.S.G, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1987.

R3. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, Machine Vision, Tata McGraw Hill, 1991.

R4. Yoremkoren, Robotics for Engineers, McGraw-Hill, USA, 1987.

R5. P.A. Janaki Raman, Robotics and Image Processing, Tata McGraw-Hill, 1991.

Online Resources:

W1. https://swayam.gov.in/nd1_noc20_me03

W2. https://swayam.gov.in/nd1_noc19_me74

COURSE NAME: FLUID POWER AUTOMATION					
COURSE CODE : RM634P					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	3	0	2	CIA Marks	**50**
Contact Hrs./Sem.	45	0	30	ESE Marks	**50**
Credits.	3	0	1	Exam Hours	**3**

Course objectives:

• Upon completion of this course students will demonstrate an understanding of Hydraulic and Pneumatic principles, equipment, seals and industries.

• Students will be able to identify and describe the basic operation of Hydraulic / Pneumatic systems, the various equipment used in their operation, Hydraulic / Pneumatic terms as well as actuator Sealing Device design / material strengths and weaknesses.

• Students will be able to troubleshoot Hydraulic/Pneumatic equipment and Seals.

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1	
Introduction To Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. **The Source of Hydraulic Power:** Pumps, classification pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. **Hydraulic Actuators and Motors:** Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).	**9**
Unit-2	

Control Components In Hydraulic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. **Hydraulic Circuit Design and Analysis**: Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Hydraulic circuit for force multiplication, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits.	**9**
Unit-3	
Maintenance of Hydraulic System: Hydraulic Oils - Desirable properties, general type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid -particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting. **Introduction To Pneumatic Control**: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. **Pneumatic Actuators:** Linear cylinder - Types, Conventional type of cylinder-working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols.	**9**
Unit-4	
Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. 3Hrs Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling. **Signal Processing Elements:** Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications.	**9**
Unit-5	
Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).	**9**

Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application. **Compressed Air:** Production of compressed air- Compressors Preparation of compressed air-Driers, Filters, Regulators, Lubricators, Distribution of compressed air -Piping layout.	
List of Experiments (If any):	**Practical Hours**
1. Introduction to Pneumatic and Hydraulic symbols	**2**
2. To Control of a Casting Ladle movement using one-way flow control valve	**2**
3. To Feed a pin continuously using limit switches	**2**
4. To use a pneumatic timer in welding of plastic sheet	**4**
5. To determine the pressure for stamping a badge with uniform press using double acting cylinders	**2**
6. To control a furnace door using manual operated hydraulic valve	**2**
7. To control a surface Grinding machine	**2**
8. To determine the hydraulic pressure for a Drilling machine	**4**
9. To use hydraulic motor and accumulator for an Earth Drill used in construction site	**2**
10. To utilize the pressure sequence valve to handle a garbage box used in solid waste management.	**2**
11. Using directional control flow valves for distributing Billiard Balls	**2**
12. To feed a paper roll for the next stage of process	**4**
Self-study : NIL	
Site/Industrial Visits : NIL	
Course outcomes: CO1: Understand the operating principle, performance and selection procedure of hydraulic elements and machines. {L1}{PO1} CO2: Understand the working principle of actuators and evaluate actuator performance and justify selection of actuators for various applications. {L2}{PO2} CO3: Identify different types of control valves and understand their working principle and application.{L2}{PO2} CO4: Design and analyse hydraulic circuits. {L3}{PO3}	

CO5: Understand and explain the multicylinder application and the control of electro-pneumatic system. {L2}{PO2}

Text Books:

T1. Anthony Esposito, "Fluid Power with Applications", 7TH edition, Pearson Education, Inc., 2014.

T2.Andrew Parr, "Pneumatics and Hydraulics", Jaico Publishing Co, 2005.

Reference Books:

R1. S. R. Majumdar, "Oil Hydraulic systems Principles and Maintenance", Tata Mc Graw Hill Publishing Company Ltd., 2001.

R2.Pippenger, Hicks, "Industrial Hydraulics", McGraw Hill, New York.

R3.Harry L. Stewart, "Hydraulic & Pneumatic Power for Production",

R4.S. R. Majumdar, "Pneumatic Systems", Tata Mc Graw Hill Publishers, 1995.

R5.Michael J Pinches & John G Ashby, "Power Hydraulics", Prentice Hall.

R6.Jagadeesha T, Hydraulics and Pneumatics", I K International Publishing House, Private Ltd.

R7.R Srinivasa, "Hydraulic and Pneumatic Control", 2nd Edition, Tata Mc Graw Hill Publication

Online Resources:

W1. https://swayam.gov.in/nd1_noc20_me22

W2. https://swayam.gov.in/nd1_noc19_me53

COURSE NAME: INTERNSHIP					
COURSE CODE :HS637					
	L	**T**	**P**	Category	**HSMC**
Contact Hrs./Week	**0**	**0**	**4**	CIA Marks	**50**
Contact Hrs./Sem.	**0**	**0**	**30**	ESE Marks	**0**
Credits.	**0**	**0**	**2**	Exam Hours	**1**

Course objectives:

- Get an inside view of an industry and organization/company
- Gain valuable skills and knowledge
- Make professional connections and enhance student's network
- Get experience in a field to allow the student to make a career transition

Prerequisites: NIL

Units	**Teaching Hours**
Unit-1	
The student shall undergo an Internship for 60 days starting from the end of 2nd semester examination and completing it during the initial period of 7th semester. 2.The department shall nominate a faculty as a mentor for a group of students to prepare and monitor the progress of the students 3. The students shall report the progress of the internship to the mentor/guide at regular intervals and may seek his/her advise. 4. The Internship shall be completed by the end of 7th semester. 5. The students are permitted to carry out the internship outside India with the following conditions, the entire expenses are to be borne by the student and the University will not give any financial assistance. 6. Students can also undergo internships arranged by the department during vacation. 7. After completion of Internship, students shall submit a report to the department with the approval of both internal and external guides/mentors. 8. There will be an assessment for the internship for 2 credits, in the form of report assessment by the guide/mentor and a presentation on the internship given to department constituted panel.	

Self-study : NA

Site/Industrial Visits : NA

Course outcomes:

CO1: To experience a 60 days internship training, enabling the student for onsite visits, study projects and practical training.(L1,L2,L3,L4)(PO1,PO2,PO3,PO9,PO10)

CO2: To develop a skill for handling multiple situations, practical problems, analysing team work and communication abilities. (L1,L2)(PO2, PO3, PO8, PO9, PO10).

CO3: To integrate theory with practice and carry out performance objectives on strong work ethics, persistence, adaptability and critical (L1, L2, L3) (PO2, PO3 PO4, PO8, PO9, PO10).

CO4: To analyse work environment and create solution to problems. (L3,L4,L5) (PO2, PO3 PO4, PO8, PO9, PO10, PO12).

CO5: To build a record of work experience and construct a good relationship with the employers. (L2,L3,L4,L5)(PO3, PO6 PO7, PO8, PO9, PO10, PO12).

Text Books:

T1.Pamela Myers Kiser, "Human Services Internship: Getting the Most From Your Experience", Cengage Learning, 4th Edition, 2016. (ISBN13: 978-1305087347)

T3.H. Frederick Sweitzer, "Successful Internship", Brooks/Cole Publishing Co., 5th Edition, 2019.

Reference Books:

R1. Bill Hobbs, Zach Schleien, "Hacking the Internship Process (Work)", La Plata Press, Paperback, 2017.

Online Resources:

W1. http://nptel.ac.in

24. PROGRAMME ELECTIVE

PROGRAMME ELECTIVE-1 (ME 534 E)										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	RM 534 E1	Automotive Engineering	3	0	0	100	3	0	0	3
2	RM 534 E2	Tribology and Bearing Design	3	0	0	100	3	0	0	3
3	RM 534 E3	Finite Element Methods	3	0	0	100	3	0	0	3
4	RM 534 E4	Material Science and Technology	3	0	2	100	3	0	1	4
5	RM 534 E5	Data Structure	3	0	0	100	3	0	0	3

COURSE NAME: ADVANCED AUTOMOTIVE ENGINEERING					
COURSE CODE : RM 534 E1					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- To impact knowledge to students in various systems of Automobile Engineering.
- To learn the fundamental principles, construction and auxiliary systems of automotive engines.
- To have excellent vision with ability to see small details at close range of students.
- To utilize and build upon the current knowledge of modern automotive manufacturing and engineering.
- To have strong logical and analytical skills in Automotive Engineering.

Prerequisites: Basic knowledge on IC engines

Units	**Teaching Hours**
Unit-1:Engine Components and Cooling & Lubrication Systems	
Introduction: Automobile history and development, Chassis, frames, articulated and rigid vehicles and vehicles layout, Prime movers. Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder - arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve	11

and port timing diagrams, Types ofcombustion chambers for S.I.Engine and C.I.Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements. **Fuels, Fuel Supply Systems For SI and CI Engines**: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburettors, C.D.& C.C. carburettors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors.	
Unit-2: Superchargers and Turbochargers	
Introduction: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger **Power Trains:** General arrangement of clutch, Principle of friction clutches, Torque transmitted, Constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Free wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches.	**8**
Unit-3: Transmission system and Differential	
Introduction: Propeller shaft, Universal joint, constant velocity joint, Hotchkiss drive, torque tube drive. Differential - Need and types, Rear Axles and Front Axles **Brakes:** Need, types Mechanical, hydraulic, Pneumatic Brakes, Electrical Brakes, Engine Exhaust brakes, Drum and Disc brakes, Comparison. Details of components, Brake adjustment, Brake by wire, Advantages over power Braking System	**8**
Unit-4: Steering, Tyres and suspension systems	
Introduction: Principle of steering, Center point steering, Steering linkages, Steering geometry and wheel alignment, Power Steering, Special steering systems. Electrical assist steering, Steering by wire, Advantages of Steering by wire. Tyres and suspension systems: Tyres, tyres specification, Factors affecting tyre performance, Special tyres, Wheel balancing, Suspension systems - Function of Spring and shock absorber, conventional and Independent suspension System, Telescopic shock absorber, Linked suspension systems. Semi-active and fully-active suspension system, Advantages offully active suspension system. **Electrical Systems:** Construction, Operation and maintenance of Batteries, Advanced lead acid batteries, Alkaline batteries, Lithium batteries, Alternator working Principles and Operation of regulators, Starter motor, Battery Ignition and Magneto Ignition Systems, Ignition Timing. Electronics Ignition, Lighting, Horn, Side indicator wiper	**10**
Unit-5: Automotive Emission Control Systems	
Introduction: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter, Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III norms. **Advanced Features In Automobile:** Recent advances such as ABS, Electronic Power Steering, Steer by wire, Traction control, Active suspension, Collision avoidance, Intelligent lighting, Navigational aids and Intelligent vehicle highway system	**8**

Self-study :
Unit-1: Fuel injection pumps and injectors.
Unit-2:Numerical calculations for torque transmission by clutches.
Unit-3: Advantages over power Braking System
Unit-4: Lighting, Horn, Side indicator wiper
Unit-5: Bharat Stage II, III norms

Site/Industrial Visits :
1. Engines Lab.

Course outcomes:
The students will be able to
CO1: To describe chassis, body and engine components of automobile.(L1)(PO1,PO2)
CO2: To demonstrate knowledge of clutch and gear box.(L1,L2) (PO1,PO2)
CO3: To demonstrate knowledge of engine injection and ignition systems. (L1,L2)(PO1,PO2)
CO4: To demonstrate knowledge of steering, brakes and suspension systems. (L1,L2) (PO1,PO2)
CO5: To describe environmental impact of emissions from vehicles and methods for controlling it. (L1,L2) (PO1,PO2,PO5,PO7)
CO6: To demonstrate knowledge on advanced features of automobile.(L1,L2) (PO1,PO2,PO4)

Text Books:
T1. Crouse, W.H., and Anglin, D.L"Automotive Mechanics", Tata McGraw Hill, New Delhi, 2009
T2. Heitner, J"Automotive Mechanics", CBS Publisher, New Delhi, 2006
T3. Automotive Mechanics, S. Srinivasan, Tata McGraw Hill 2003

Reference Books:
R1. Narang, G.B., "Automobile Engineering", Khanna Publishers, New Delhi, 2015
R2. Kamaraju Ramakrishna "Automobile Engineering", PHI Learning pvt. Ltd., New Delhi, 2012
R3. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van NostrandCompany, Inc
R4. Fundamentals of Automobile Engineering,K .K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
R5. Automobile Engineering, R. B. Gupta, SatyaPrakashan, 4thedn. 1984.
R6. Automobile engineering, Kirpal Singh. Vol I and II 2002.

Online Resources:
W1. https://nptel.ac.in/syllabus/125106002/

COURSE NAME: TRIBOLOGY and BEARING DESIGN					
COURSE CODE :RM 534 E2					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- Describe surface topography, physio-chemical aspects of solid surfaces, and surface interactions.
- Analyze the mechanics of solid elastic and elastoplastic contacts.
- Recognize the laws of friction, mechanisms of friction, friction space, stiction, stick slip, and surface temperature.
- Appreciate the various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive, oxidational (mild and severe), melt, and the wear-mechanism maps.
- Identify types of lubrication: boundary, solid-film, hydrodynamic, and hydrostatic lubrication.
- Examine applications/case studies: sliding contacts, rolling contacts, bearing design, coating selection, and lubrication.
- Explore the design oftribological surfaces and how to troubleshoot tribology problems.

Prerequisites: Fluid Mechanics, Strength of Material

Units	**Teaching Hours**
Unit-1	
Introduction to Tribology: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants. **Hydrodynamic Lubrication:** Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, idealized full journal bearings.	**9**
Unit-2	
Mechanism of Pressure Development in an Oil Film: Reynold's investigations, Reynold's equation in two dimensions. Partial journal bearings, end leakages in journal bearing, numerical problems.	**10**
Unit-3	
Slider / Pad Bearing with a Fixed and Pivoted Shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, influence of end leakage, numerical example.	**9**
Unit-4	

Oil Flow and Thermal Equilibrium of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings. **Hydrostatic Lubrication:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.	**9**
Unit-5	
Bearing Materials: Commonly used bearings materials, properties of typical bearing materials. **Wear:** Classification of wear, wear of polymers, wear of ceramic materials, wear measurements, effect of speed, temperature and pressure. **Behavioroftribological components:** Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.	**9**
Self-study : NA	
Site/Industrial Visits :NA	
Course outcomes: Upon completion of this course, the students will be able to CO1: Apply the basic theories of friction and wear to predictions about the frictional behaviour of commonly encountered sliding interfaces. {L3}{PO1,PO2} CO2 Apply the principles of lubrication to solve engineering problem.{L3}{PO1,PO2} CO3: Analyze the effects of friction, wear and lubrication in Metal working process {L4}{ PO2 } CO4: Select materials for tribological applications.{L1, L2}{PO1} CO5: Analyze the mechanism of pressure development in oil film {L4}{PO1,PO2} CO6: Find the load carrying capacity of journal bearing {L3}{PO2}	
Text Books: T1. Basu S K., Sengupta A N., Ahuja B. B., "Fundamentals ofTribiology", PHI, New Delhi, 2012 T2. Mujumdar B. C.,"Introduction to TribiologyBearings", S. Chand company pvt. Ltd 2010.	
Reference Books: R1. Fuller.D"Theory and Practice of Lubrication for Engineers",New York company 1998 R2. Moore "Principles and Applications ofTribiology", Pergamaon press 1998. R3. Srivastava S"Tribiology in Industries", S Chand and Company limited, Delhi 2001 R4. Redzimovskay E I "Lubrication of bearings – Theoretical Principles and Design", Oxford press company 2000.	
Online Resources: W1. https://nptel.ac.in/courses/112102014/	

COURSE NAME: FINITE ELEMENT METHODS					
COURSE CODE : RM 534 E3					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**50**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives:

• To provide the student with some knowledge and analysis skills in applying basic laws in mechanics and integration by parts to develop element equation for a spring element and steps used in solving the problem by finite element method.

• To develop the student's skills in applying the basic matrix operation to form a global matrix equation and enforce the concept of steps in obtaining solutions for a truss structures.

• To develop the student's skills in applying the Hermite interpolation functions to solve beam problems.

• To provide the student with some knowledge and analysis skills in forming basic data required in a FEM computer program.

• To develop the student's skills in applying the Gaussian quadrature in computing integration in FEM.

• To provide the student with some knowledge in isoperimetric transformation.

Prerequisites: Knowledge of Partial Derivation and Integration
ME334 - Strength of Material

Units	**Teaching Hours**
Unit-1	
Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width.	**9**
Unit-2	
Euler - Lagrauge equation for bar, beam (cantilever / simply supported fixed) Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method.	**9**
Unit-3	
Interpolation Models: Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements. 2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element. **Solution of 1-D Bars:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique.	**9**
Unit-4	

Higher Order Elements: Langrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements. Numerical integration: 1, 2 and 3 gauge point for 1D and 2D cases. **Trusses:** Stiffness matrix of Truss element. Numerical problems	**9**
Unit-5	
Beams: Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. **Heat Transfer:** Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction. Galerkin's approach for heat conduction. 1D heat transfer in thin fins	**9**
List of Experiments (If any):	**Practical Hours**
Part - A 1.Study of a FEA package and modelling stress analysis of Bars of constant cross section area, tapered cross section area and stepped bar	**2**
2.Trusses – (Minimum 2 exercises)	**4**
3.Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc. (Minimum 6 exercises)	**8**
Part - B 4.Stress analysis of a rectangular plate with a circular hole	**4**
5.Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises)	**4**
6.Dynamic Analysis (a)Fixed – fixed beam for natural frequency determination	**2**
Dynamic Analysis (b)Bar subjected to forcing function	**2**
Dynamic Analysis (c)Fixed – fixed beam subjected to forcing function	**4**
Self-study : NIL	
Site/Industrial Visits : NIL	
Course outcomes: CO1: Comprehend the concept of FEM in Engineering Applications. (L2) (PO1, PO2, PO3, PO5) CO2:Determine the deflection/deformation of beam & bar by using RR method &Galeriken method. (L1, L2, L3)(PO1, PO2, PO3, PO4 PO5). CO3:Determine the stress developed in bar by using elimination and penalty method. (L1, L2, L3)(PO1, PO2, PO3, PO4, PO5) CO4:Determine the deformation &stresses in trusses by using elimination method. (L1, L2, L3)(PO1, PO2, PO3, PO4, PO5) CO5:Determining the temperature distribution of a thin film by using conduction & convection principle. (L1, L2, L3)(PO1, PO2, PO3, PO4, PO5).	

Text Books:

T1. T.R.Chandrupatla, A.D Belegund, "Introduction to Finite Elements in Engineering", 3rd edition, PHI, 2002.
T2. S.S. Rao, "Finite Element Method in Engineering", 5th Edition, Elsevier, 2011.

Reference Books:

R1.U.S. Dixit, "Finite Element Methods for Engineers", Cengage Learning, 2009.
R2.R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, "Concepts and applications of Finite Element Analysis", 4th edition, Wiley, 2009.
R3.Daryl. L. Logon, "First Course in Finite Element Methods", 5th edition, Cengage Learning, 2012.
R4.J.N.Reddy, "An Introduction to the Finite Element Method", 3rd Edition, McGraw -Hill Pulication, 2006.

Online Resources:

W1.https://nptel.ac.in/

COURSE NAME: MATERIAL SCIENCE AND TECHNOLOGY					
COURSE CODE : RM 534 E4					
	L	**T**	**P**	Category	**PCC**
Contact Hrs./Week	**3**	**0**	**2**	CIA Marks	**70**
Contact Hrs./Sem.	**45**	**0**	**30**	ESE Marks	**30**
Credits.	**3**	**0**	**1**	Exam Hours	**3**

Course objectives: At the end of the course, students will be able to

- Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
- To provide a detailed interpretation of equilibrium phase diagrams
- Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Crystal Structure& Mechanical Property Measurement	
Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress **Mechanical Property Measurement:** Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength	**13**
Unit-2:Static Failure Theories & Fracture Mechanics	
Static Failure Theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; **Fracture mechanics:** Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT)	**9**
Unit-3: Phase Diagrams	
Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects ofledeburite, austenite, ferrite and cementite, cast iron.	**7**
Unit-4: Heat Treatment of Steel	
Heat Treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties-austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.	**7**
Unit-5: Ferrous and Non-Ferrous Alloys	

Alloying of steel, properties of stainless steel and tool steels, mar aging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys	**9**
List of Experiments (If any):	**Practical Hours**
10. Study of Sand testing tools and equipment's	**2**
11. Compression tests on universal testing machine	**2**
12. Permeability tests on Permeability tester	**2**
13. Sieve analysis tests	**2**
14. Clay content determination in base sand	**2**
15. Rapid Moisture tester	**2**
16. Study of foundry practice tools	**2**
17. Mould without pattern (Solid Hexagonal prism+ Square)	**2**
18. Mould Without pattern (Concentric Circles)	**2**
19. Mould with pattern (Dumb Bell Shape)	**2**
20. Mould with pattern (Pelton Wheel Cup)	**2**
21. Study of Forging and Smithy tools	**2**
22. Hexagonal Headed Bolt	**2**
23. L Shape with a triangular faced joint	**2**
24. Flat or Conical headed Rivet	**2**
Self-study: Nil	
Site/Industrial Visits: Nil	
Course outcomes: CO1: Student will be able to identify crystal structures for various materials and understand the defects in such structures. (L3, L4)(PO2) CO2: Understand how to tailor material properties of ferrous and non-ferrous alloys. (L1, L2, L3)(PO2,3,4,5) CO3: Define the fatigue, fracture and creep factors in a material. (L2, L4, L5)(PO1) CO4: How to quantify mechanical integrity and failure in materials. (L2, L3, L4, L5)(PO1,2,3,4,5) CO5: Determine the phase diagrams and compositions for different class of metals and alloys. (L2, L5)(PO1,2) CO6: Identify the heat treatment process for a material in an industry. (L2, L4)(PO1,2,6)	
Text Books: T1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India. T2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002. T3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999. T4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.	
Reference Books: R1. George Diter, 2013, "Mechanical Metallurgy", McGrew Hill Education. R2. Y.Lakhtin, "Engineering Physical Metallurgy",New Delhi CBS Publishers and Distributors 1998.	
Online Resources: W1. http://nptel.ac.in/courses/113106032/ (Introduction to Materials Science and Engineering) W2. http://nptel.ac.in/courses/113102080/ (Introduction to Materials Science and Engineering)	

W3. http://nptel.ac.in/courses/113106075/ (Defects in materials)

W4. http://nptel.ac.in/courses/112104203/ (Nature and property of materials)

W5. http://nptel.ac.in/courses/113104076/(Nature and property of materials)

COURSE NAME: DATA STRUCTURES					
COURSE CODE :RM 534 E5					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- To impart a thorough understanding of linear data structures such as stacks, queues and their applications.
- To impart a thorough understanding of non-linear data structures such as trees, graphs and their applications.
- To impart familiarity with various sorting, searching and hashing techniques and their performance comparison.
- To impart a basic understanding of memory management.

Prerequisites: Basic computer programming

Units	**Teaching Hours**
Unit-1	
Introduction to programming methodologies – structured approach, stepwise refinement techniques, programming style, documentation – analysis of algorithms: frequency count, definition of Big O notation, asymptotic analysis of simple algorithms. Recursive and iterative algorithms.	**9**
Unit-2	
Abstract and Concrete Data Structures- Basic data structures – vectors and arrays. Applications, Linked lists:- singly linked list, doubly linked list, Circular linked list, operations on linked list, linked list with header nodes, applications of linked list: polynomials.	**10**
Unit-3	
Applications of linked list (continued): Memory management, memory allocation and de-allocation. First-fit, best-fit and worst-fit allocation schemes Implementation of Stacks and Queues using arrays and linked list, DEQUEUE (double ended queue). Multiple Stacks and Queues, Applications.	**9**
Unit-4	
String: - representation of strings, concatenation, substring searching and deletion. Trees: - m-ary Tree, Binary Trees – level and height of the tree, complete-binary tree representation using array, tree traversals (Recursive and non-recursive), applications. Binary search tree – creation, insertion and deletion and search operations, applications.	**9**
Unit-5	
Graphs – representation of graphs, BFS and DFS (analysis not required) applications. Sorting techniques – Bubble sort, Selection Sort, Insertion sort, Merge sort, Quick sort, Heaps and Heap sort. Searching algorithms (Performance comparison expected. Detailed analysis not required)	**9**
Self-study : NA	

Site/Industrial Visits :NA

Course outcomes: Upon completion of this course, the students will be able to
CO1: To compare different programming methodologies and define asymptotic notations to analyze performance of algorithms. {L3}{PO1,PO2}
CO2: To use appropriate data structures like arrays, linked list, stacks and queues to solve real world problems efficiently.{L3}{PO1,PO2}
CO3: To represent and manipulate data using nonlinear data structures like trees and graphs to design algorithms for various applications.{L4}{ PO2 }
CO4: To illustrate and compare various techniques for searching and sorting.L1, L2}{PO1}
CO5: To appreciate different memory management techniques and their significance.{L4}{PO1,PO2}
CO6: To illustrate various hashing techniques.{L3}{PO2}

Text Books:

T1. Samanta D., Classic Data Structures, Prentice Hall India, 2/e, 2009.
T2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning, 2005.

Reference Books:

R1. Horwitz E., S. Sahni and S. Anderson, Fundamentals of Data Structures in C, University Press (India), 2008.

R2. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication,1983.

R3. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill, 1995.

R4. Peter Brass, Advanced Data Structures, Cambridge University Press, 2008

R5. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series, 1986.

R6. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall, 2004.

R7. Hugges J. K. and J. I. Michtm, A Structured Approach to Programming, PHI, 1987.

R8. Martin Barrett, Clifford Wagner, And Unix: Tools For Software Design, John Wiley, 2008 reprint.

Online Resources:
W1. https://nptel.ac.in/courses/106102064/

COURSE NAME: GREEN BELT PRACTICE					
COURSE CODE : ME636OE01					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: By the end of this course, you should be able to:

1. Lead a Team, using the DMAIC process to solve a problem
2. Use Statistical tools to analyse data and prove or disprove a hypothesis
3. Understand the difference between tools, to select and use the appropriate one(s)
4. Apply Lean to solve problems encountered in business settings
5. Train White and Yellow Belts to strengthen your own knowledge of these tools and concepts.
6. Provide project updates and presentation of results to management with associated savings

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction: Different Definitions and Dimensions of Quality, Historical Perspective (From Evolution of Quality Control, Assurance and Management to Quality as Business Winning Strategy), Contribution of Renowned Quality Gurus (Their Philosophies and Impact on Quality).	**9**
Unit-2	
Quality Engineering and Management Tools, Techniques & Standards: (A) Statistical Quality Control: Causes of Variation, Control Charts for Variables (Mean and Range, Mean and Standard Deviation, Cumulative Sum Control Chart), Control Chart Patterns and Corrective Actions, Control Charts for Attributes (p-chart, np chart,c-chart, u-chart), Acceptance Sampling Plans (Concepts of Producer's and Consumer's Risks, Types of Sampling Plans and their merits and demerits, Operating Characteristic Curve,	**9**

Average Outgoing Quality Curve), Errors in Making Inferences from Control Charts (Type I and II errors).	
Unit-3	
Quality Engineering and Management Tools, Techniques & Standards: (B) Quality Control & Improvement Tools: 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke Quality Circle, Cost of Quality Technique. Quality Engineering and Management Tools, Techniques &Standards:(C) Quality Assurance and Management: ISO:9000, ISO:14000,QS:9000 (Concept, Scope, Implementation Requirements &Barriers, and Benefits)	**9**
Unit-4	
Designing For Quality: Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) – Concept, Methodology and Application. Quality in Service Sectors: Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors.	**9**
Unit-5	
Six Sigma Fundamentals: Basic Concept, Methodology, Process Improvement Model (DMAIC)Steps (Objectives, Tools and Techniques Used), Six Sigma Organization, Six Sigma Implementation Requirements, Introduction to Lean Six Sigma.	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1: Understand the concepts of quality control, improvement and management. (L1)(PO1,PO2, PO11) CO2: Understand and apply different tools & techniques of quality engineering and management(L3)(PO1,PO2,PO5, PO11) CO3: Understand the concept of design for quality(L2)(PO1,PO2,PO8,PO11) CO4: Understand and apply the concept and importance of service quality.(L2)(PO1,PO2,PO8,PO11) CO5: Understand quality management standards(L2)(PO1,PO2,PO11,PO12) CO6: Understand the latest quality improvement methodology; Six Sigma.(L1)(PO1,PO2,PO5,PO11)	

Text Books:

T1. Amitava Mitra "Fundamentals of Quality Control and Improvement", Prentice – Hall International Edition.

T2. Frank M. Gryna, Richard C. H. "Juran's Quality Planning & Analysis for Enterprise Quality", Tata McGraw Hill Edition.

T3. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre "Total Quality Management", Pearson Educaiton.

T4. Craig W. Baird "The Six Sigma Manual for Small and Medium Businesses", Yes Dee Publishing Pvt. Ltd.

T5. N. Logothetis "Managing for Total Quality", Prentice Hall of India Pvt. Ltd.

Reference Books:

R1. Eugene L. Grant and Richard S. Leavenworth "Statistical Quality Control", Tata McGraw-Hill Publishing Company Ltd.
R2. B. L. Hanson & P. M. Ghare "Quality Control & Application", Prentice Hall of India
R3. J. M. Juran & F. M. Gryna "Quality Control Handbook", Prentice Hall Publications.
R4. K C Arora "Total Quality Management", S K Kataria & Sons.
R5. Dr. S. Kumar "Total Quality Management", Laxmi Publication Pvt. Ltd.
R6.Warren Brussee "All About Six Sigma", Tata McGraw Hill Edition

Online Resources:

W1. https://nptel.ac.in/

COURSE NAME: FACILITY PLANNING AND DESIGN					
COURSE CODE : ME636OE02					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: Student is expected to

1. Understand the importance of Facilities Planning Processes and Material Handling Systems.

2. Define and analyse various types of layouts and their linkages to design of product, process and systems.

3. Solve facility design problems through analysing layout models and computer aided layout designs.

4. Design and develop an integrated facilities layout and material handling systems for various Industrial Applications.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction: Facilities planning definition, significance of facilities planning, objectives of facilities plan, facilities planning process, strategic planning process, developing facilities planning strategies, examples of inadequate planning.	**9**
Unit-2	
Designing of Material Flow, Activity Relationship and Space Requirement: product design, process design schedule design, facilities design flow system, Material flow system, Departmental planning, activity relationships and space requirement	**9**
Unit-3	
Materials Handling Systems: Introduction, scope and definition of material handling, material handling principles, designing material handling systems, unit load design, material handling equipment, estimating material handling costs, safety considerations.	**9**
Unit-4	

Layout Planning Models and Design Algorithms: Basic layout types, layout procedures, algorithmic approaches, departmental shapes and mail aisles, simulated annealing and Genetic algorithms, multi floor layout packages, commercial facility layout packages, developing layout alternatives.	**9**
Unit-5	
Facility Design For Various Facilities Functions: warehouse operations facility location models, special facility layout models, machine layout models, conventional storages models, automated storage and retrieval systems, order picking systems, fixed path material handling models, simulation models.	**9**
Self-study :	
Site/Industrial Visits :	

Course outcomes:

CO1: Understand the factors influencing decisions related to plant location, layout and Material Handling Systems. (L1,L2)(PO1,PO10,P11)
CO2: Recognize the influences of product and process design as well as analyse their effects on the facility layout design problems.(L2,L3,L4)(PO1.PO2,PO3,PO4,PO6,PO10)
CO3: Develop systematic facility layout plans using mathematical models and algorithmic approaches. (L1,L2,L3)(PO2,PO3,PO10)
CO4: Evaluate alternative facilities planning and design solutions. (L2,L3,L4,L5) (PO2,PO3,PO4,PO6,PO7PO10,PO11)
CO5: Create an integrated facilities plan for various applications,(L3,L4,L5,L6) (PO3,PO4,PO5,PO7,PO10)

Text Books:

T1. James A Tompkins, John A. White, Yavuz A. Bozer, "Facilities Planning", 3rdEdition, Wiley India, ISBN- 978-81-265-1781-7, 2009.
T2. James M Apple, "Plant Layout and Material Handling", 3rd Edition, Krieger Pub Co., ISBN-13: 978-0894645457, January 1991.

Reference Books:

R1. Francies R.L. and White J.A. "Facility layout and Location", Prentice Hall of India, 2nd Edition, ISBN: 8120314603, 1998.
R2. Sunderesh Heragu, "Facilities Design", PWS Publishing Company, 4th Edition, ISBN-0- 595 359388, 2006.

Online Resources:

W1.https://nptel.ac.in/

COURSE NAME: BASIC AUTOMOBILE ENGINEERING					
COURSE CODE : ME636OE03					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**48**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:The objective of this course is to impact knowledge to students in various systems of Automobile Engineering and to learn the fundamental principles, construction and auxiliary systems of automotive engines

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction: Classification of vehicles, options of prime movers, transmission and arrangements. **Engine:** Engine classifications, number of strokes, cylinders, types of combustion chambers for petrol and diesel engines, valves, valve arrangements and operating mechanisms, piston, design basis, types, piston rings, firing order, fly wheel.	**9**
Unit-2	
Fuel Supply Systems: Petrol and diesel engines, fuel pumps, Mechanical and electrical diaphragm pumps, air and fuel filters. **Carburettors and Injection System**: Carburettors, fuel injection systems for diesel and petrol engines, electronic fuel injection, super chargers, mufflers.	**9**
Unit-3	
Cooling and Lubrication system for I.C. engines: Necessity, methods of cooling, air cooling, water cooling, components of water cooling systems, Objective of lubrication, requirements of lubricant, types of lubricant, various systems of engine lubrication **Electrical System**: Ignition system, distributor, electronic ignition, magneto, dynamo, alternator, regulator, starting motor, introduction to various accessories, typical wiring diagram...	**9**
Unit-4	

Chassis: Introduction of chassis, classification, conventional construction, frameless construction, introduction to vehicle dimensions. **Transmission System:** Introduction to single plate clutch, wet and dry type, clutch actuating mechanisms, study of clutch components, fluid fly wheel. Gear box , Theory, four speed and five speed sliding mesh, constant mesh and synchromesh type, selector mechanism, automatic transmission, overdrive, transfer box four wheel drive, torque converter, propeller shaft.	**9**
Unit-5	
Suspension System: Systems, springs, shock absorbers, axles, front and rear, different methods of floating rear axle, front axle and wheel alignment, types of rims and tyres. **Steering System:** Steering mechanisms, types of brakes and brake actuation mechanisms.	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1: Describe chassis, body and engine components of an automobile.(L1, L2)(PO1,PO2) CO2: Understand knowledge of transmission, cooling and lubrication systems.(L1, L2) (PO1,PO2) CO3: Understand the working of engine injection and ignition systems.(L1, L2) (PO1,PO2) CO4: Understand the working of steering, brakes and suspension systems. (L1, L2) (PO1,PO2) CO5: Apply the knowledge in curbing the emissions from vehicles and methods for control. (L1, L2,L3) (PO1,PO2,PO3,PO4)	
Text Books: T1. Kripal Singh, "Automobile Engineering", Vol.-1 & 2, Standard publisher distributors 2015. T2. Joseph Heitner, "Automotive Mechanics", East-West student edition 2014.	
Reference Books: R1. Crouse. W.H. and Angling, D.L "Automobile Mechanics"2009. R2. Judge, A.W ,"Automobile Electrical System" R3.K.k.Ramalingam, "Automobile engineering", scitech publications 2001**.**	
Online Resources: W1.https://nptel.ac.in/	

COURSE NAME: PROJECT MANAGEMENT					
COURSE CODE : ME636OE04					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives: The course aims at the following learning targets

- To understand the concepts of project definition, life cycle, and systems approach;
- To develop competency in project scooping, work definition, and work breakdown structure (WBS)
- To handle the complex tasks of time estimation and project scheduling, including PERT and CPM
- To develop competencies in project costing, budgeting, and financial appraisal

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction to Project: Definition of a Project, Sequence of Activities, Unique activities, Complex Activities, Connected Activities, One Goal, Specified Time, Within Budget, According to Specification. Defining a Program, Project parameters: Scope, Quality, Cost, Time, Resources; The scope triangle: Time, Cost, and Resource Availability, Project Classification **Project Management:** Principles of Project Management: Defining, Planning, Executing, Controlling, Closing; Project Management Life Cycle: Phases of Project Management, Levels of Project Management	**8**
Unit-2	
Quality Management: Continuous Quality Management Model, Process Quality Management Model; Risk Management, Risk Analysis; Relationship between Project Management and other Methodologies **Project Activities:** Work Breakdown Structure, Uses of WBS, Generating the WBS: Top-Down/ Bottom-Up Approach, WBS for Small Projects, Intermediate WBS for large projects; Criteria to Test for Completeness in the WBS: Measurable Status, Bounded, Deliverable, Cost/Time Estimate, Acceptable Duration Limits, Activity Independence; Approaches to Building the WBS: various approaches, Representing WBS	**9**

Unit-3	
Activity Duration, Resource Requirements, & Cost: Duration: Resource Loading versus Activity Duration, Variation in Activity Duration, Methods for Estimating Activity Duration, Estimation Precision; Resources; Estimating Cost, JPP Session to Estimate Activity Duration & Resource Requirements, Determining Resource Requirements **Fundamentals of Project Network Diagram:** Project Network Diagram, Benefits to Network- Based Scheduling, Building the Network Diagram Using the PDM, Analysing the Initial Project Network Diagram.	**10**
Unit-4	
Network Analysis – PERT: Introduction to Project Evaluation and Review Technique, Event, Activity, Dummy, Network rules, Graphical guidelines for network, Common partial situations in network, numbering the events, Cycles; Developing the Network, Planning for network construction, modes of network construction, steps in developing network, hierarchies; Time Estimates in PERT, Uncertainties and use of PERT, Time estimates, Frequency distribution, Mean, Variance & standard deviation, Probability distribution, Beta distribution, Expected time; Time Computations in PERT, Earliest expected time, Formulation for TE, Latest allowable occurrence time, Formulation for TL, Combined tabular computations for TE, TL; Slack, Critical Path, Probability of meeting schedule date. **Network Analysis- CPM:** Introduction to Critical Path Method, Procedure, Networks, Activity time estimate, Earliest event time, Latest allowable occurrence time, Combined tabular computations for TE and TL, Start & Finish times of activity, Float, Critical activities & Critical path. Crashing of project network, Resource levelling and Resource allocation	**9**
Unit-5	
Schedules Based on Resource Availability: Resources, Levelling Resources, Acceptability Levelled Schedule, Resource Levelling Strategies, Work Packages: Purpose of a Work Package, Format of a Work Package **Joint Project Planning Session:** Planning the Sessions, Attendees, Facilities, Equipment's, Complete Planning Agenda, Deliverables, Project Proposal	**9**
Self-study :	
Site/Industrial Visits :	

Course outcomes:

CO1: Apply the concept of project management in engineering field through project management life cycle.(L3)(PO11)

CO2: Analyze the quality management and project activity in engineering field through work breakdown structure. (L4)(PO10)

CO3: Analyze the fundamentals of project and network diagram in engineering and management domain through PDM techniques. (L4)(PO1)

CO4: Evaluate the concept of network analysis through PERT and CPM techniques. (L5)(PO2)

CO5: Apply the concept of scheduler based on resource availability in engineering and management field through project proposal. (L3)(PO11)

Text Books:

T1. "Effective Project Management", Robert K. Wysocki, Robert Beck. Jr., and David B. Crane; - John Wiley & Sons 2003.

T2. Project Planning and Control with CPM and PERT" Dr. B.C. Punmia & K.K.Khandelwal; - Laxmi Publications, New Delhi 2011.

Reference Books:

R1. "Project Management" S. Choudhury, - TMH Publishing Co. Ltd, New Delhi 1998.

R2. "Total Project Management- The Indian Context" P. K. Joy, - Macmillan India Ltd., Delhi 2017.

R3. "Project Management in Manufacturing and High Technology Operations" Adedeji Bodunde Badiru, - John Wiley and Sons 2008.

R4. "Course in PERT & CPM" R.C.Gupta, - DhanpatRai and Sons, New Delhi

R5. "Fundamentals of PERT/ CPM and Project Management" S.K. Bhattacharjee; - Khanna Publishers, New Delhi 2004.

Online Resources:

W1.https://nptel.ac.in/courses/110/104/110104073/

W2. https://nptel.ac.in/courses/106/105/106105218/

COURSE NAME: BASIC AEROSPACE ENGINEERING					
COURSE CODE : ME636OE05					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives:

- To familiarize with the basics of aerodynamics
- To familiarize with the basics of aircraft structures, systems & instruments
- To give exposure to the power plants cased in Aircraft

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Aircraft Configurations: Brief History- airplanes and Helicopters – Components of an airplane and their functions. Different types of flight vehicles, classifications, Basic instruments for flying. **Introduction to Principles of Flight:** Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment, different types of drag.	**9**
Unit-2	
Introduction to Aerodynamics: Aerodynamic forces on aircraft, Basic characteristics of aerofoils, NACA nomenclature, Classification of NACA aerofoils, propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows. **Elements of Airplane Performance:** Introduction, Equation of motion, Thrust required for level unaccelerated flight, Thrust available and maximum velocity, Power required for level unaccelerated flight, Power available and maximum velocity for reciprocating engine – propeller combination and jet engine, Altitude effect of power available and power required. Rate of climb, gliding flight, Absolute and Ceiling, Time of climb, Range & Endurance for propeller driven and jet air plane.	**9**
Unit-3	
Aircraft Structures: General types of construction, Monocoque and Semi-monocoque - construction, Typical wing and fuselage Structures. **Landing Gears:** Introduction to Landing Gears, Types of Landing Gears.	**9**

Unit-4	
Aircraft Materials: Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials. **Systems and Instruments:** Conventional control, Powered controls, Basic instruments for flying, typical systems for control actuation.	**9**
Unit-5	
Jet Propulsion: Basic ideas about piston, turboprop and jet engines – comparative merits, Propellers and Jet for thrust production. **Rocket Propulsion:** Principle of operation of rocket, types of rocket and typical applications, Exploration into space, Use of multistage rockets.	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1:Appreciate the history, evolution and significance of aircrafts.(L2,L3,L4)(PO1,PO3,PO5,PO7,PO9) CO2: Effectively use International Standard Atmosphere and aerodynamic principles to calculate aerodynamic forces. (L3,L4,L5)(PO1,PO2,PO4,P6,PO8,PO11) CO3:Evaluate the performance parameters for different flight conditions.(L2,L3,L45)(PO1,PO3,PO7,PO10) CO4:Describe reference frames and derive general equations of motion for flight and orbital mechanics.(L1,L2,L3,L4)(PO2,PO4,PO6,PO8) CO5:Apply equations of motion to determine aircraft performance in steady gliding, horizontal and climbing flight.(L3,L4,L5,L6)(PO1,PO5,PO9,PO12) CO6:Distinguish and Significantly evaluate the principles and parameters of jet and rocket engines.(L2,L3,L4,L5)(PO1,PO2,PO6,PO10,PO11,PO12)	
Text Books: T1. Kermode, A.C., 'Flight without Formulae', Pearson, 2004. T2. Shevell, R.S., Fundamentals of flights, Pearson education, 2004	
Reference Books: R1. Anderson.J.D., Introduction to Flight, McGraw Hill, 2010. R2. McKinley.J.L, R.D. Bent, Aircraft Power Plants, McGraw Hill, 1993. R3. Pallet.E.H.J. Aircraft Instruments & Principles, Pearson 2010.	
Online Resources: W1.https://nptel.ac.in/	

COURSE NAME: INDUSTRIAL ROBOTICS					
COURSE CODE: ME636OE06					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives:

- To be familiar with the automation and brief history of robot and applications
- To give the student familiarities with the kinematics of robots
- To give knowledge about robot end effectors and their design
- To learn about Robot Programming methods & Languages of robot
- To give knowledge about various Sensors and their applications in robots

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Basic Concepts: Robot anatomy, Manipulators, kinematics: Forward and inverse kinematics, Precision movement, robot specifications and Work volume, Types of Robot drives **Robot Control:** Basic robot motions, Point to point control, continuous path control. Robot control, unit control system concept, servo and non, servo control of robot joints, adaptive and optimal control	**9**
Unit-2	
End Effectors: Classification, mechanical, magnetic, vacuum and adhesive gripper, gripper force analysis and design **Sensor Devices:** Types of sensors, contact, position and displacement sensors, Force and torque sensors, Proximity and range sensors, acoustic sensors, Robot vision systems, Sensing and digitizing, Image processing and analysis	**9**
Unit-3	
Robot Cell Design: Robot work cell design and control, Safety in Robotics, Robot cell layouts **Robot Interference:** Robots and machine interference, Robot cycle time analysis	**9**

Unit-4	
Robot Programming: Robot language classification, programming methods, off and on line programming **Simple Programs:** Lead through method, Teach pendent method, VAL systems and language, simple program	**9**
Unit-5	
Industrial Applications: Application of robots, Material handling, Machine loading and unloading, Assembly, Inspection, Welding, Spray painting **Recent Developments in Robotics:** Mobile robot, Microbots, Recent developments, safety considerations	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1: Explain the basic components of robots.(L2)(PO1,PO2) CO2: Differentiate types of robots, sensors and robot grippers(L3)(PO1,PO2) CO3: Compare forward and inverse kinematics of robot manipulators(L2)(PO1,PO2,PO4) CO4: Programme a robot to perform tasks in industrial applications(L3)(PO1,PO2,PO4,PO5) CO5: Design robot cell considering robot safety and its control(L6)(PO1,PO2,PO4,PO5) CO6: Summarize industrial applications and Recent developments in Robotics(L2)(PO1,PO2)	
Text Books: T1. Deb .S.R, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, New Delhi, 2010 T2. Mikell P. Groover, "Industrial Robotics Technology Programming and Applications", McGraw Hill Co., Singapore, 2009.	
Reference Books: R1. Klafter.R.D, Chmielewski.T.A and Noggins, "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd., New Delhi, 2009. R2. Fu K.S, Gonzalez.R.C,& Lee, C.S.G, "Robotics control, sensing, vision and intelligence", McGraw Hill Book Co., Singapore, Digitized 2010 R3. Craig.J.J, "Introduction to Robotics mechanics and control", Addison, Wesley, London, 2009.	
Online Resources: W1. https://nptel.ac.in/courses/112/105/112105249/ W2. https://www.udemy.com/course/industrial-robotics/	

COURSE NAME: NON-DESTRUCTIVE TESTING					
COURSE CODE : ME636OE07					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives:

NDT techniques are used for locating flaws as well as for characterizing material properties. Flaws within the materials can play havocs and may cause planes to crash, reactors to fail, trains to derail, pipelines to burst and alike. However if wedetect the flaws using NDT techniques, all these catastrophic failures can be avoided. Use of NDT techniques results in better confidence in the material and one may opt for lower value of factor of safety.

Prerequisites: Material science and Metallurgy, Primary Manufacturing, Engineering Metrology, Advanced Manufacturing Technology

Units	**Teaching Hours**
Unit-1	
Introduction to Non-Destructive Testing: An Introduction, Visual examination, Basic Principle, The Eye, Optical aids used for visual inspection, Applications. **Liquid Penetrant Testing:** Physical principles, Procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods, Sensitivity, Applications, Limitations and Standards.	**9**
Unit-2	
Magnetic Particle Testing: Magnetism-basic definitions and principle of. magnetic particle testing, Magnetizing techniques, Induced current flow, Procedure used for testing a component, Equipment Used for magnetic particle testing , Sensitivity, Limitations. **Eddy Current Testing**: Principles, Instrumentation for eddy current testing Techniques. Sensitivity Advanced Eddy Current Test Methods, Applications, Limitations, Standards.	**9**
Unit-3	
Radiography: Basic principle, Electromagnetic radiation, Sources, Radiation attenuation in the specimen. Effect of radiation in film, Radiographic imaging, Inspection techniques, Applications of radiographic inspection, Limitations, Real	**9**

time radiography, Safety in Industrial Radiography, Standards, Neutron radiography. **Ultrasonic Testing:** Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for Normal Beam Inspection, Techniques for Angle Beam Inspection, , Flaw characterization techniques, Ultrasonic flaw detection equipment, Modes of Display, Immersion Testing, Applications of Ultrasonic Testing, Advantages, Limitations, Standards, Mechanical Impedance Analysis Technique.	
Unit-4	
Acoustic Emission Testing: Principle of Acoustic Emission Testing, Technique, Instrumentation, Sensitivity, Applications, Standards. **Thermograph:** Basic Principles, Detectors and Equipment, Techniques, Applications, Codes and Standards. **In Situ Metallographic Examination**: Approach to the Selection of Site for Metallographic examination, Replication process, Significance of Microstructure observation, Decision making, Applications, Codes and Standards. **Leak testing:** Measurement of Leakage,	**9**
Unit-5	
Comparison and Selection of NDT Methods: Defects in Materials, Metallurgical process and defects. Defects introduced during service, Selection of the Non-Destructive testing Method, Selection of instrumentation **Probability of Detection Concepts in NDT:** Introduction, Probability of Detection, The Typical Approach Methodology for Establishing Probability of Detection, Role of Probability of Detection Concepts during Design and Operation. **Codes, Standards, Specification and Procedures:** Code, Standards, Indian National Standards for Non-Destructive Testing, International Standards for Non-Destructive Testing.	**9**
Self-study : NA	
Site/Industrial Visits : NA	

Course outcomes:

CO1: Describe the various NDT techniques, equipment, applications and limitations.(L1, L2)(PO1,PO2)

CO2: Select the appropriate NDT method for various components according NDT standards and interpret the defects. (L1, L2, L3) (PO1,PO2,PO3)

CO3: Explain the concept of Thermograph and elaborate the leak testing methods.(L1, L2, L4) (PO1,PO2,PO4)

CO4: Discuss and summarize the Codes, standards, specification and procedures involved in NDT techniques.(L1, L2, L3) (PO1,PO2,PO3)

Text Books:

T1. Raj Baldev, "Practical Non Destructive Testing", Narosa Publishing House, New Delhi, 2005.

T2. Mc Gonnagle JJ, "Non Destructive Testing", McGraw hill publications, 1989.

Reference Books:

R1. Prasad J, "Non-destructive Test & Evaluation of Materials", Tata McGraw-Hill, New Delhi, 2008.

R2. Boyer, H.E, and T.L. Gall, "Metals Hand Book", American Society for Metals, 1988.

Online Resources:

W1. https://nptel.ac.in/courses/113106070/

COURSE NAME: ENERGY AND ENVIRONMENT					
COURSE CODE : ME636OE08					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives:

- Understand energy scenario, energy sources and their utilization
- Learn about methods of energy storage, energy management and economic analysis
- Have proper awareness about environment and eco system.
- Understand the environment pollution along with social issues and acts.

Prerequisites: Basic knowledge on Mechanical Engineering

Units	**Teaching Hours**
Unit-1	
Basic Introduction To Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.	**9**
Unit-2	
Energy Storage Systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems. Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing. **Energy Audit:** Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. Economic Analysis: Scope, Characterization of an Investment Project.	**9**
Unit-3	
Environment: Introduction, Multidisciplinary nature of environmental studies-Definition, scope and importance, Need for public awareness. **Ecosystem:** Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.	**9**

Unit-4	
Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.	**9**
Unit-5	
Social Issues and The Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1: Summarize the basic concepts of energy, its distribution and general Scenario. (L1,L2,L3)(PO1,PO2,PO3,PO6,PO7) CO2: Explain different energy storage systems, energy management, audit and economic analysis. (L1,L2,L3,L4) (PO1,PO2,PO3,PO6,PO7) CO3: Summarize the environment eco system and its need for awareness. (L1,L2,L3,L4) (PO1,PO2,PO3,PO6,PO7) CO4: Identify the various types of environment pollution and their effects. (L1,L2,L3,L4) (PO1,PO2,PO3,PO6,PO7) CO5: Discuss the social issues of the environment with associated acts. (L1,L2,L3,L4) (PO1,PO2,PO3,PO6,PO7)	
Text Books: T2. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune T2. De, B. K., "Energy Management audit & Conservation", 2nd Edition, Vrinda Publication, 2010.	

Reference Books:

R1. Turner, W. C., Doty, S. and Truner, W. C., "Energy Management Hand book", 7th edition, Fairmont Press, 2009.

R2. Murphy, W. R., "Energy Management", Elsevier, 2007.

R3. Smith, C. B., "Energy Management Principles", Pergamum, 2007

R4. C S rao "Environment pollution control Engineering" 2nd edition, New Age International, 2006, reprint 2015.

R5. Benny Joseph "Environmental studies", Tata McGraw Hill, 2008, 2nd edition.

Online Resources:

W1. https://www.ceew.in/

W2.https://www.teriin.org/projects/teddy/pdf/Energy_and_environment_goals_discussion_paper.pdf

W3. https://www.youtube.com/watch?v=UeGJpwC1aiQ (NPTEL Mod-01 Lec-01 Energy Resources and Environment)

W4: http://www.nptelvideos.in/2012/12/fundamentals-of-environmentalpollution.html

COURSE NAME: ALTERNATE ENERGY SOURCES FOR AUTOMOBILES					
COURSE CODE : ME636OE09					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives: The objectives of this course is to

- Describe need for alternative fuels for internal combustion engine and alternative drive systems for automobiles
- Describe principle of solar energy collection, construction of photo voltaic cells
- Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
- Explain use of hydrogen for internal combustion engine application.
- Describe use of various gaseous fuels for internal combustion engine application.
- Understand various aspects of electrical and Hybrid vehicles

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction: Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels and drivetrains. Scenario of conventional auto fuels, oil reserves of the world. Fuel quality aspects related to emissions. Technological up gradation required business driving factors for alternative fuels. Implementation barriers for alternative fuels. Stakeholders of alternative fuels, roadmap for alternative fuels. **Solar Energy:** Solar energy geometry, solar radiation measurement devices. Solar energy collectors, types of collectors. Direct application of solar energy, solar energy storage system. P. V. effect solar cells and characteristics. Application of solar energy for automobiles.	**9**
Unit-2	
Biogas: History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas. Production, properties, Engine performance, advantages and disadvantages of Methanol, Ethanol, Butanol, Straight vegetable oil, Biodiesel for internal combustion engine application.	**9**

Unit-3	
Hydrogen: Properties and production of hydrogen, Storage, Advantages and disadvantages of hydrogen, use of Hydrogen in SI and CI engines. Hazards and safety systems for hydrogen, hydrogen combustion. Emission from hydrogen. **Gaseous Fuels:** Production, properties, Engine performance, advantages and disadvantages of CNG, LNG, ANG, LPG and LFG.	**9**
Unit-4	
Reformulated Conventional Fuels: Introduction. Production of coal water slurry, properties, as an engine fuel, emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline. **Future Alternative Fuels:** Production, properties, Engine performance, advantages and disadvantages of PMF, Ammonia, Liquid-Nitrogen, Boron, Compressed Air, Water as fuel for internal combustion Engine.	**9**
Unit-5	
Alternative Power Trains: Components of an EV, EV batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEV drive train components, advantages of HV. History of dual fuel technology, Applications of DFT. Duel fuel engine operation. Advantages and disadvantages of duel fuel technology.	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1: Describe need for alternative fuels for internal combustion engine and alternative drive systems for automobiles(L1,L2)(PO1,PO2) CO2: Describe principle of solar energy collection, construction of photo voltaic cells(L1,L2) (PO1,PO2,PO5) CO3: Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel (L1, L2) (PO1, PO2) CO4: Explain use of hydrogen for internal combustion engine application. (L1,L2,PO5) CO5: Describe use of various gaseous fuels for internal combustion engine application. (L1,L2) (PO1,PO2) CO6: Explain various aspects of electrical and Hybrid vehicles(L1,L2) (PO1,PO2)	

Text Books:

T1. S .S. Thipse "Alternative Fuels". JAICO Publishing House.

T2. G. D. Rai "Non-Conventional Energy Sources", Khanna Publishing New Delhi

Reference Books:

R1. M. Poulton "Alternative fuels for Vehicle"

R2. R. Bechtold "Alternative fuels guide". SAE

R3. T.N Veziroglu "Alternative energy sources ", McGraw Hill

R4. A Primer on Hybrid Electric vehicles

R5. Richard L. Bechtold "Automotive Fuels Guide", SAE Publications, 1997

Online Sources:

W1: https://onlinecourses.nptel.ac.in/noc17_mm16/preview (Laws of Thermodynamics)

W2: http://nptel.ac.in/courses/103101004/17 (e-Content from basics to laws)

W3: http://nptel.ac.in/courses/112105123/ (Videos from basics to applications)

W4: http://www.mace.manchester.ac.uk/courses-cuip/ug/mechanical- engineering/meng-mechanical-engineering-4years/course-unit- spec/?unitcode=MACE32102

W5: https://ocw.mit.edu/high-school/physics/exam-prep/kinetic-theory-thermodynamics/laws-of-thermodynamics/

W6: https://podcasts.ox.ac.uk/keywords/thermodynamics

W7: https://ivle.nus.edu.sg/V1/lms/public/view_moduleoutline.aspx? CourseID=0946a05a-0d1d-4d9b-8e1a-d96875da0c7b

COURSE NAME: ADVANCED MANUFACTURING TECHNOLOGY					
COURSE CODE : ME636OE10					
	L	**T**	**P**	Category	**OE**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Courseobjectives:

To provide a basic knowledge on manufacturing Processes and selection of the process for production. To provide a basic knowledge about the casting process casting defects, melting furnaces, moulding techniques. To gain sound knowledge about welding process and its application in fabrication areas. To provide basic knowledge about various machining processes and their applications e.g. Lathe, Drilling, Milling, Grinding etc….

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1	
Introduction To Manufacturing: Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process. Sand Moulding: Types of base sand, requirement of base sand. Moulding sand mixture ingredients for different sand mixtures. Method used for sand moulding, such as Green sand, dry sand and skin dried moulds. Cores: Definition, Need, Types. Method of making cores, Binders used, core sand moulding. Concept of Gating & Risers.	**10**
Unit-2	
Primary manufacturing: Lathe - Principle of working of a centre lathe. Parts of a lathe. Operations on lathe - Turning, Facing, Knurling, Thread Cutting, Drilling, Taper turning by Tailstock offset method, Compound slide swivelling method and Specification of Lathe. Different types of lathes and their applications.	**9**
Unit-3	
Drilling and Milling: Classification, constructional features of upright, multiple spindle, deep hole & automatic drilling machine**.** Classification, constructional	**9**

features of bed type, planer, special purpose milling machine, milling cutter nomenclature **Grinding and Shaping:** Types of abrasives, Grain size, bonding process, grade and structure of grindingwheels, grinding wheel types**.** Constructional features of a Shaper. **Capstun Turret and SPM:** Classification, constructional features, Tool Layout of Turret & Capstan Lathe and SPM	
Unit-4	
CNC Machining: Introduction to CNC machines- Principles of operation. Axes of NC machine-Coordinate systems. Basics of Manual part programming methods. Definition, types –Fixed, Programmable & Flexible automation, NC/ CNC machines: Basic elements with simple block diagrams, advantages and disadvantages.	**8**
Unit-5	
Rapid Prototyping: Need for the compression in product development, history of RP systems, and classification of RP systems. Stereo Lithography Systems, Fusion Deposition Modelling and Selective Laser Sintering**:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application	**9**
Self-study :	
Site/Industrial Visits :	
Course outcomes: CO1: Classify the manufacturing process and identify the basic requirements of the casting process.(L1,L2)(PO1,PO2) CO2: Understand various parts and machining operations on lathe (L1,L2) (PO1,PO2) CO3: Understand the constructional features and working operations of drilling, shaping, milling and grinding (L1,L2) (PO1,PO2) CO4: Analyse the programming of NC/CNC with the advantages and disadvantages (L4) (PO1,PO2,PO4) CO5: To understand the need of rapid prototyping and classify the different systems in rapid prototyping.(L2) (PO1,PO2)	
Text Books: T1. Stereo Lithography and other RP & M Technologies, Paul F.Jacob s: SME, NY 1996.	

T2. Production Technology: Manufacturing Processes, Technology and Automation 17th Edition" by R K Jain, Khanna Publishers, 2012.

Reference Books:

R1. Manufacturing Engineering and Technology, Steven R Schmid, Serope Kalpakjian, Pearson publication, 2014.

R2. "Manufacturing Technology: Foundry, Forming and Welding", 4e (Volume 1) [Kindle Edition], McGraw Hill (14 May 2013), ASIN: B00H1Q21EO.

Online Resources:

W1. https://nptel.ac.in/courses/112/107/112107078/

Course Name: Python Programming					
Course Code: RM731E1					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- understand the most important libraries of Python, and its recommended programming styles and idioms.
- learn core Python scripting elements such as variables and flow control structures. 3. develop applications using Python.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Python, Data Types, Expressions	
Python Programming - Running Code in the Interactive Shell, Input, Processing and Output, Editing, Saving and Running a Script - Data Types, String Literals, Escape Sequences, String Concatenation, Variables and the Assignment Statement - Numeric Data Types and Character Sets - Integers and Long Integers, Floating-Point Numbers and Character Sets - Expressions - Arithmetic Expressions and Mixed-Mode Arithmetic and Type Conversions.	**9**
Unit-2: Functions, Modules and Control Statements	
Functions and Modules - Calling Functions, The math Module, The Main Module, Program Format and Structure and Running a Script from a Terminal Command Prompt - Iteration - for loop - Selection - Boolean Type, Comparisons, and Boolean Expressions, if-else Statements, One-Way Selection Statements, Multi-way if Statements, Logical Operators and Compound Boolean Expressions	**9**
Unit-3: Strings and Text Files	
Strings - Accessing Characters and Substrings in Strings, Data Encryption, Strings and Number Systems and String Methods - Text Files - Text Files and Their Format, Writing Text to a File, Writing Numbers to a File, Reading Text from a File, Reading Numbers from a File and Accessing and Manipulating Files and Directories on Disk.	**9**
Unit-4: Lists and Dictionaries	
Lists - List Literals and Basic Operators, Replacing an Element in a List, List Methods for Inserting and Removing Elements, Searching and Sorting a List, Mutator Methods and the Value None, Aliasing and Side Effects, Equality and Tuples - Defining Simple Functions - Syntax, Parameters and Arguments, return Statement, Boolean Functions and main function, DICTIONARIES - Dictionary Literals, Adding Keys and Replacing Values, Accessing Values, Removing Keys and Traversing a Dictionary.	**9**
Unit-5: Design with Functions and Design with Classes	

Design with Functions and Design with Classes - Functions as Abstraction Mechanisms, Problem Solving with Top-Down Design, Design with Recursive Functions and Managing a Program'sNamespace - DESIGN WITH CLASSES - Objects and Classes, Data Modeling and Structuring Classes with Inheritance and Polymorphism.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: CO1: Describe the datatypes, expressions and type conversions in Python {L1} {PO1} CO2: Apply functions, control statements, strings, lists and dictionaries in python programming. {L2} {PO2} CO3: demonstrate the concept of object, class inheritance and polymorphism in Python. {L3} {PO2} CO4: Write user defined functions, classes in python{L3} {PO2} CO5: Develop GUI based Python program and to read and write files using python programming. {L2} {PO2}	
Text Books: T1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, July 2005. T2. Paul Barry, "Head First Python 2e", O'Reilly, 2nd Revised edition, 2016, ISBN-13: 978-1491919538.	
Reference Books: R1. Zed A. Shaw, "Learn Python the Hard Way", Addison-Wesley, Third Edition, 2014, ISBN-13: 978-0-321-88491-6. R2. Dave Kuhlman, "A Python Book: Beginning Python, Advanced Python, and Python Exercises", 2013, ISBN: 9780984221233. R3. Kent D Lee, "Python Programming Fundamentals", Springer-Verlag London Limited, 2011, ISBN 978-1-84996-536-1	
Online Resources: W1. https://wiki.python.org/moin/BeginnersGuide	

Course Name: Data Communication Networking					
Course Code: RM731E2					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- To introduce fundamental communication models.
- To discuss various time domain and frequency domain concepts of data communication.
- To introduce the concepts of encoding, multiplexing and spread spectrum.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Data Transmission	
Data Transmission: Communication model Simplex,half duplex and full duplex transmission – PeriodicAnalog signals: Sine wave, phase, wavelength, timeand frequency domain, bandwidth - Digital Signals;Digital data Transmission:- Analog & Digital data,Analog & Digital signals, Analog &Digitaltransmission – Transmission Impairments:Attenuation, Delay distortion, Noise – Channelcapacity: Nyquist bandwidth, Shannon's Capacity formula	**9**
Unit-2: Transmission media	
Guided Transmission Media:Twisted pair, Coaxial cable, optical fiber, WirelessTransmission, Terrestrial microwave, Satellitemicrowave. Wireless Propagation: Ground wavepropagation, Sky Wave propagation, LoSPropagation.	9
Unit-3: Signal Encoding techniques	
Digital Data DigitalSignals: NRZ, Multilevel binary, Biphase – DigitalData Analog Signals : ASK, FSK, PSK - Analog DataDigital Signals: Sampling theorem, PCM, DeltaModulation - Analog Data Analog Signals: AM, FM,PM.	**9**
Unit-4: Digital Data Communication Techniques	
Asynchronous transmission, SynchronousTransmission-Detecting and Correcting Errors-Typesof Errors-Error Detection: Parity check, CyclicRedundancy Check (CRC) - Error Control ErrorCorrection: Forward Error Correction and HammingDistance.	**9**
Unit-5: Spread Spectrum Techniques-Direct Sequence	
. Spread Spectrum (DSSS), Frequency HoppingSpread Spectrum (FHSS).Basic principles of switching - Circuit SwitchedNetworks, Structure of Circuit Switch – PacketSwitching: Datagram Networks, Virtual CircuitNetworks, Structure of packet switches.	**9**

Self-study: NIL

Site/Industrial Visits: NIL

Course outcomes:

CO1: Identify and list the various issues present in the design of a data communication system{L1} {PO1}

CO2:Apply the time domain and frequency domain concepts of signals in data communication. {L2} {PO2}

CO3:Compare and select transmission media based on transmission impairments and channel capacity. {L3} {PO2}

CO4: Select and use appropriate signal encoding techniques and multiplexing techniques for a givenscenario{L3} {PO2}

CO5:Design suitable error detection and error correction algorithms to achieve error free datacommunication and explain different switching techniques. {L2} {PO2}

Text Books:

T1. William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc

T2. Forouzan B. A., Data Communications and Networking, 5/e, Tata McGraw Hill, 2013

Reference Books:

R1. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning

R2. Forouzan B. A., Data Communications and Networking, 4/e, Tata McGraw Hill, 2007.

R3. Tanenbaum A. S. and D. Wetherall, Computer Networks, Pearson Education,

Online Resources:

Course Name: Mobile Application Development					
Course Code: RM731E3					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- Understand system requirements for mobile applications
- Generate suitable design using specific mobile development frameworks
- Generate mobile application design
- Implement the design using specific mobile development frameworks
- Deploy the mobile applications in marketplace for distribution

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Introduction	
Introduction to mobile applications – Embedded systems - Market and business drivers for mobile applications – Publishing and delivery of mobile applications – Requirements gathering and validation for mobile applications	**9**
Unit-2: Basic Design	
Introduction – Basics of embedded systems design – Embedded OS - Design constraints for mobile applications, both hardware and software related – Architecting mobile applications – user interfaces for mobile applications – touch events and gestures – Achieving quality constraints – performance, usability, security, availability and modifiability	**9**
Unit-3: Advanced Design	
Designing applications with multimedia and web access capabilities – Integration with GPS and social media networking applications – Accessing applications hosted in a cloud computing environment – Design patterns for mobile applications	**9**
Unit-4: Technology I - Android	
Introduction – Establishing the development environment – Android architecture – Activities and views – Interacting with UI – Persisting data using SQLite – Packaging and deployment – Interaction with server-side applications – Using Google Maps, GPS and Wifi – Integration with social media applications.	**9**
Unit-5: Technology Ii - IOS	
. Introduction to Objective C – iOS features – UI implementation – Touch frameworks – Data persistence using Core Data and SQLite – Location aware applications using Core Location and Map Kit – Integrating calendar and address book with social media application – Using Wifi - iPhone marketplace.	**9**

Self-study: NIL

Site/Industrial Visits: NIL
Course outcomes: CO1: Explain the challenges in mobile application design and development{L1} {PO1} CO2:Develop design for mobile applications for specific requirements {L2} {PO2} CO3:Implement the design using Android SDK {L3} {PO2} CO4: Implement the design using Objective C and iOS{L3} {PO2} CO5: Deploy mobile applications in Android and iPhone marketplace for distribution{L2} {PO2}
Text Books: T1. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", Wrox, 2012 T2. Charlie Collins, Michael Galpin and Matthias Kappler, "Android in Practice", DreamTech, 2012.
Reference Books: R1. James Dovey and Ash Furrow, "Beginning Objective C", Apress, 2012 R2. David Mark, Jack Nutting, Jeff LaMarche and Frederic Olsson, "Beginning iOS 6 Development: Exploring the iOS SDK", Apress, 2013.
Online Resources: W1. http://developer.android.com/develop/index.html

Course Name: Sensors and Actuators					
Course Code: RM731E4					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- Understanding basic laws and phenomena on which operation of sensors and actuators-transformation of energy is based,
- Conducting experiments in laboratory and industrial environment.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Introduction and Displacement Measurement	
Sensors - Basic requirements of a sensors- Classification of sensors- Static and Dynamic characteristics of sensors- Displacement Sensors- Linear and Rotary displacement sensors-Potentiometer, Capacitive and Inductive type displacement sensor- position sensors- Optical encoder, Photoelectric sensor, Hall Effect Sensor.	**8**
Unit-2: Measurement of Proximity, Force and Pressure	
Eddy current proximity sensor- Inductive Proximity sensor- Capacitive Proximity sensor -Pneumatic Proximity sensors- Proximity Switches- Contact and Noncontact type – Strain Gauge – Diaphragm Pressure Sensor- Capsule Pressure sensors- Bellows Pressure Sensor- Bourdon tube pressure sensor- Piezoelectric Sensor- Tactile sensor.	10
Unit-3: Measurement of Velocity, Flow and Level	
Tachogenerator - Pyroelectric sensors - Ultrasonic sensor – Resistive sensor- Pitot tube – Orificeplate - flow nozzle- Venturi tubes – Rotameter- Electromagnetic flow meter. Float level sensor- Pressure level sensor- Variable capacitance sensor.	**8**
Unit-4: Measurement of Temperature, Motion and Light	
Thermocouples- Thermistors -Thermodiodes – Thermotransistors- Bimetallic Strip- Resistance Temperature Detector- Infrared Thermography. Vibrometer and accelerometer- seismic accelerometer. Photoresistors -Photodiodes - Phototranistors- Photocondutors	**10**
Unit-5: Micro Sensors and Actuators	
. Micro Sensors: Principles and examples, Force and pressure micro sensors,position and speed micro sensors, acceleration micro sensors, chemical sensors,biosensors, temperature micro sensors and flow micro sensors.Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles	**9**
Self-study: NIL	

Site/Industrial Visits: NIL
Course outcomes: CO1: Explain fundamental physical and technical base of sensors and actuators, {L1} {PO1} CO2:create analytical design and development solutions for sensors and actuators, {L2} {PO2} CO3:. Describe development and application of sensors and actuators,{L3} {PO2} CO4:Describe basic laws and phenomena that define behaviour of sensors and actuators {L2} {PO2} CO5: interpret the acquired data and measured results{L2} {PO2}
Text Books: T1. Gardner, J. W., Microsensors, Principles and Applications, John Wiley (2008) T2. William T., Micromechanics and MEMS, IEEE Press (1997)
Reference Books: R1. Measurement systems application and design, ERNEST DOEBELIN, IV Edn R2. Electronic Instrumentation – by H S Kalsi TMH 2nd Ed 2004.
Online Resources: W1. https://swayam.gov.in/nd1_noc19_ee41/

Course Name: Wireless Sensor Networks					
Course Code: RM731E5					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- To expose the students to wireless sensor networks (WSNs).
- To enable the students to learn how to cope with complete systems, starting with
- hardware design and low-level programming throughout applications and data
- processing.
- To teach the students to build set of skills and expertise in WSNs by designing and
- implementing

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Overview of Wireless Sensor Networks & Architectures	
Introduction to wireless sensor networks, Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs), Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.	**9**
Unit-2: Networking Sensors	
Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.	**8**
Unit-3: Infrastructure Establishment & Data Storage	
Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Data Storage and Manipulation: Data centric and content-based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique	**9**
Unit-4: Sensor Network	
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms. Applications: Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring	**9**
Unit-5: Sensor Network Platforms and Tools	

. Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms,Node-level Simulators, State-centric programming.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: CO1: Explain the basic concepts of wireless sensor networks, sensing, computing and communication tasks{L1} {PO1} CO2:. Describe and explain radio standards and communication protocols adopted in wireless sensor networks{L2} {PO2} CO3:. Describe and explain the hardware, software and communication for wireless sensor network nodes.{L2} {PO2} CO4: Explain the architectures, features, and performance for wireless sensor network systems and platforms{L2} {PO2} CO5: Describe and analyze the specific requirements of applications in wireless sensor networks for energy efficiency, computing, storage and transmission{L2} {PO2}	
Text Books: T1. Holger Karl & Andreas Willig, " Protocols and Architectures for Wireless Sensor Networks" John Wiley, 2005... T2. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007..	
Reference Books: R1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, And Applications", John Wiley, 2007.. R2. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2013.	
Online Resources: **W1.**https://www.kth.se/social/files/5431a388f276540a05ad2514/An_Introduction_WSNS_V1.8.pdf	

COURSE NAME: RAPID PROTOTYPING					
COURSE CODE : RM732E1					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: This course provides the fundamental knowledge to Rapid Prototyping and Automated fabrication, including the generation of suitable CAD models, current Rapid Prototyping fabrication technologies, their underlying material science, the use of secondary processing, and the impact of these technologies on society. The rapid prototyping process will be illustrated by the actual design and fabrication of a part.

Prerequisites: Computer Aided Machine Drawing

Units	**Teaching Hours**
Unit-1	
Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. **Stereo Lithography Systems:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	**9**
Unit-2	
Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Application, Fusion Deposition Modelling Principle, Process parameter, Path generation, Applications. **Solid Ground Curing:** Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.	**9**
Unit-3	
Concepts Modelers: Principle, Thermal jet printer, Sander's model market,3-D printer. GenisysXs printer HP system 5, object Quadra systems. **Rapid Tooling:** Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM.	**9**
Unit-4	
Rapid Tooling: Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc, .Direct Rapid Tooling Direct. AIM. **Rapid Tooling:** Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.	**9**
Unit-5	
Software for RP: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools. **Rapid Manufacturing Process Optimization:** Factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.	**9**

Self-study :
Site/Industrial Visits :
Course outcomes: CO1: { Identify the stages of development related to RP system and classification based of material types } {L1} {PO1} CO2:{ Compare different RP process based on process parameter} {L2}{PO1} CO3:{ Analyze the different Rapid Tooling process for batch production}{L2}{PO1} CO4:{ Select and use correct data formats in the manufacture of a 3D printed part}{L3}{PO1} CO5:{ Analyse suitable orientation workflow for better part fabrication process & reduced part build errors}{L3}{PO2} CO6: {Demonstrate the 3-D model using 3-D printer}{L3}{PO3}
Text Books: T1. Paul F.Jacob"Stereo Lithography and other RP & M Technologies", SME, NY 1996. T2. FlhamD.T&Dinjoy S.S Verlog"Rapid Manufacturing", London 2001.
Reference Books: R1. Rapid Prototyping, Terry Wohler's Report 2000"Wohler's Association 2000. R2. Gurumurthi "Rapid Prototyping Materials", IIScBangalore. R3. Lament wood "Rapid Automated", Indus press New York.
Online Resources: W1. https://www.classcentral.com/course/swayam-rapid-manufacturing-13019

Course Name: Machine Learning Using Python Programming					
Course Code: RM732E2					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- Understand Python language basics and how they apply to data science.
- Practice iterative data science using Jupyter notebooks.
- Analyse data using Python libraries like pandas and NumPy.
- Create stunning data visualizations with matplotlib, folium, and seaborn.
- Build machine learning models using SciPy and scikitlearn.
- Demonstrate proficiency in solving real life data science problems**.**

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Introduction to Machine Learning	
Applications of Machine Learning Supervised vs Unsupervised Learning Python libraries suitable for Machine Learning	**9**
Unit-2: Regression	
Simple and multiple **linear regression**, Polynomial **regression** and orthogonal polynomials, Test of significance and confidence intervals for parameters Non-linear Regression Model evaluation methods, subset selection of explanatory variables, Mallow's Cp statistic.	**9**
Unit-3: Classification	
K-Nearest Neighbour, Decision Trees, Logistic Regression, Support Vector Machines, Model Evaluation	**9**
Unit-4: Python Programming Fundamentals	
Types, Expressions and Variables, String Operations Lists and Tuples, Sets, Dictionaries Conditions and Branching, Loops, FunctionsObjects and Classes	**8**
Unit-5: Case studies	
Statistics and probability, Regression, time series, clustering, classification	**9**

Self-study: NIL

Site/Industrial Visits: NIL

Course outcomes:

CO1: Develop an appreciation for what is involved in learning models from data.{L1} {PO1}
CO2:Understand a wide variety of learning algorithms. {L2} {PO2}

CO3:Understand how to evaluate models generated from data {L3} {PO2} CO4:Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models {L3} {PO2} CO5: Apply python programing for ML applications {L3} {PO2}
Text Books: T1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition. T2. Stephen Marsland, Machine Learning: An Algorithmic Perspective.
Reference Books: R1. Christopher M. Bishop, Pattern Recognition and Machine Learning. R2. Kent D Lee, "Python Programming Fundamentals", Springer-Verlag London Limited, 2011, ISBN 978-1-84996-536-1
Online Resources: W1. https://wiki.python.org/moin/BeginnersGuide W2 http://www.cs.cmu.edu/~tom/NewChapters.html

Course Name: Artificial Intelligence for Mechatronics Systems					
Course Code: RM732E3					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- Gain Knowledge of Artificial Intelligence, Production Rules, Search Algorithms, Expert System & its architectures, Machine Learning.
- Understand the working methodology of Search Algorithms, Expert System & Machine Learning.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Introduction	
Definition and Introduction to Mechatronics Systems. Modelling&Simulation of Physical systems Overview of Mechatronics Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.	**9**
Unit-2: Signal Conditioning:	
Signal conditioning, the operational amplifier, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation. MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing	**9**
Unit-3: Space Representation	
Defining the Problem, Production Rules for water jug problem, Breadth-First Search Algorithm, Depth-First Search Algorithm, Generate & Test Algorithm, Hill Climbing Algorithms: Simple Hill Climbing Algorithm, Steepest-Ascent Hill Climbing Algorithm.	**9**
Unit-4: Expert Systems	
Introduction, Characteristics of Expert System, Need of an Expert System, Expert System Architecture, Steps to develop an Expert System, case studies: MYCIN ,DENDRAL. and Neural Nets: Introduction ,TAN-Toy Adaptive Node ,Network Structures, Application of Neural Nets.	**8**
Unit-5: Introduction to Machine Learning:	
.Introduction, Perceptrons, Perceptron Learning Algorithm, Checkers Playing Examples, Learning automata: Automaton model, Temperature Control Model, CLA representation of NIM game, Genetic Algorithms, Intelligent editors	**8**

Self-study: NIL

Site/Industrial Visits: NIL
Course outcomes: CO1: have Knowledge of Artificial Intelligence, Production Rules, Search Algorithms, Expert System & its architectures, Machine Learning{L2} {PO1} CO2:understand the working methodology of Search Algorithms, Expert System & Machine Learning. {L2} {PO2}
Text Books: T1. Artificial Intelligence, Elaine Rich & Kevin Knight, M/H 2004. T2. Introduction to AI & ES, Dan W. Patterson, Prentice Hall of India, 2012. T3. Artificial Intelligence A Practical Approach, Er.Rajiv Chopra, S.Chand & Company Ltd,2012.
Reference Books: R1. Principles of Artificial intelligence, Springer Vertag, Berlin, 1981. R2. Building Expert Systems, Hayes, Roth, Waterman, D. A. Addison Wesley, 1983. R3. A guide to Expert systems, Waterman, D. A. Addison – Wesley inc. 1986.
Online Resources: W1. https://nptel.ac.in/courses/106/102/106102220/

Course Name: PLC and SCADA					
Course Code: RM732E4					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

1. To know the importance and benefits of automation and to understand how to automate an industrial process using PLC.
2. To understand the instructions of PLC
3. To program PLC using the Ladder diagrams.
4. Be aware of applications of timers, counters and effective use of program flow control instructions to manage PLC operations.
5. Appreciate the need for DCS/ SCADA in Process Control Instrumentation
6. To Understand the working of HMI Automation

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: PLC Hardware	
Definition of Automation, Types and applications in Industry, Basic concepts of PLC, PLC components – I/O configuration, Introduction to PLC operation, Binary data representation, Input and Output status files, sixteen point I/O modules,PLCmemory.Architecture of PLC:- Modular and brick type.I/O Modules: D/I, D/O, A/I, A/O and communication modules. PLC symbols, Advantages and Disadvantages of PLC, List PLC applications. Communication to PC and PLC through serial, MODBUS, Ethernet	**9**
Unit-2: Basics of PLC Programming	
Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.	**9**
Unit-3: Special Programming Instructions	
Timer and Counter Instructions: On delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counter and timers.Program Control and Data manipulation Instructions: -Data handling instructions, Sequencer instructions, Programming sequence output instructions, Comparison and selection of Industrial PLC for automation. Introduction to Variable Frequency Drive and its applications with PLC	**9**
Unit-4: DCSStructure	

DCS architecture, Makes of DCS, Database organization in DCS, System elements ofDCS: -Fieldstation, Intermediate station, Central computer station, Reliability parameters of DCS, Classification of alarms in DCS, Comparison of DCS with PLC	**9**
Unit-5: Introduction to SCADA	
SCADA system application(Oil GAS / factory /Metro/ Solar Power Plant /Steel Plant),Calculation SCADA tag, Selection of Software basis of SCADA Tag, Creating Database of Tags,SCADA Screen /Creating & Editing graphic display with animation,o Data Entry / Start Stop command,Analog entrySizing, Movement, Blinking, Visibility, Filling,Trending,Creating & Accessing Real-time, Creating& Accessing Historical Trend	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: CO1: Automate an industrial process using PLC{L1} {PO1} CO2:program PLC using the Ladder diagrams {L2} {PO2} CO3:applications of timers, counters and effective use of program flow control instructions to manage PLC operations {L3} {PO2} CO4:Appreciate the need for DCS/ SCADA in Process Control Instrumentation{L3} {PO2}	
Text Books: T1. Programmable Logic Controllers, W Bolton, Elsevier T2. Programmable logic controllers by John W Webb Ronald A Reis, PHI, 5th edition, 2007, ISBN 9-788-1203-2308-7	
Reference Books: R1. Introduction to Programmable Logic Controllers by Garry Dunning,Thomson,2nd edition,Thomson,ISBN: 981-240-625-5 R2Programmable Logic Controllers, JR Hackworth, Frederick , Pearson Education R3. Learning Programmable Logic Controllers with Applications, PK Srivstava,BPB Publications. R4 Practical SCADA for Industry, David Bailey and Edwin wright, Newnes An imprint ofElsevier, 2003, ISBN 07506 58053	
Online Resources: W1. https://www.advanceelectricaldesign.com/Syllabus-of-PLC-SCADA-Training-Course.php	

Course Name: Embedded Systems					
Course Code: RM732E5					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: To impart knowledge on the Building blocks of Embedded System, Various embedded Development Strategies, Bus Communication in processors, Input/output interfacing. processor scheduling algorithms.Basics of Real time operating system

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1: Introduction to Embedded Systems	
Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging	**10**
Unit-2: Embedded Computing Platform Design	
The CPU Bus-Memory devices and systems–Designing with computing platforms – consumer electronics architecture – platform-level performance analysis – Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.	**10**
Unit-3: Sensor Interfacing with Arduino	
Basics of hardware design and functions of basic passive components-sensors and actuators-Arduino code – library file for sensor interfacing-construction of basic applications	**8**
Unit-4: Embedded Firmware	
Reset Circuit, Brown-out Protection Circuit-Oscillator Unit – Real Time Clock-Watchdog Timer – Embedded Firmware Design Approaches and Development Languages.	**10**
Unit-5: Embedded System Application and Development	
. Case Study of Washing Machine- Automotive Aplication- Smart card System Aplication-ATM machine –Digital camera	**6**

Self-study: NIL

Site/Industrial Visits: NIL

Course outcomes:

- CO1:Describe the architecture and programming of ARM processor. {L1} {PO1}
- CO2:. Explain the concepts of embedded systems{L2} {PO2}
- CO3:. Understand the Concepts of peripherals and interfacing of sensors{L3} {PO2}
- CO4:Capable of using the system design techniques to develop firmware {L3} {PO2}
- CO5: Illustrate the code for constructing a system{L2} {PO2}

Text Books:

T1. Rajkamal, 'Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013.
T2Peckol, "Embedded system Design", John Wiley & Sons,2010
T3 Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013

Reference Books:

R1. Shibu. K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill,2009.
R2. Elicia White," Making Embedded Systems", O' Reilly Series,SPD,2011.
R3. Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning,2009.

Online Resources:

W1.https://embeddedartistry.com/beginners/
W2 https://www.coursera.org/learn/interface-with-arduino

Course Name: Operation Research					
Course Code: RM831 E1					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

• One or more advanced courses on applications in: supply chain and manufacturing systems; data analysis; information engineering; financial engineering; or service systems.

• A collaborative systems design experience.

• Collaborative project experiences involving both written and oral presentations.

• Courses with significant experiential learning components.

• Experiences with identifying, accessing, evaluating, and interpreting information and data in support of assignments, projects, or research.

• Course experiences with large-scale datasets.

Prerequisites: Mathematics (MA131, MA231, MA331, MA431)

Units	**Teaching Hours**
Unit-1:	
INTRODUCTION: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP), problem-formulation and solution by graphical method, Genetic Algorithm. **SOLUTION OF Linear Programming PROBLEMS:** The simplex method- slack, surplus and artificial variables, big M method and concept of duality, dual simplex method, Meta Heuristics & Genetic Algorithm.	**9**
Unit-2:	
TRANSPORTATION PROBLEM: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem.	**9**
Unit-3:	
PERT-CPM TECHNIQUES: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	**9**

Unit-4:	
QUEUING THEORY: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models – M/M/1 and M/M/C models and their steady state performance analysis.	**9**
Unit-5:	
GAME THEORY: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. SEQUENCING: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: CO1: Express the applications of Operations Research and mathematical modeling in solving industrial problems and to solve Engineering and managerial situations as LPP.(L2)(PO1,PO2,PO12) CO2:Compute Engineering and managerial situations as Transportation and Assignment problems using quantitative methods which include MODI method and Hungarian method .(L3)(PO1,PO2,PO11) CO3:Evaluate the trouble spots in a project namely the delays , interruptions by determining the critical factors using CPM and PERTH technique CO4:Solve for the congestions and delays of waiting in line using Queuing Theory.(L3)(PO1,PO2) CO5:Solve for competitive situations using analytical and graphical methods of Game theory. (L3)(PO1,PO2) CO6:Selection of appropriate order in which jobs (operations)are assigned to facilities using Sequencing methodology (L3)(PO1,PO2)	
Text Books: T1. P K Gupta and D S Hira, "Operations Research", 6th edition, Chand Publications, New Delhi , 2014. T2.Taha H A, "Operations Research", 10th edition, Pearson Education, 2016. T3.El-Ghazali Talbi, "Metaheuristics: From Design to Implementation", 2013 Edition, Wiley Publishers, ISBN-13: 978-0470278581 T4.Kalavathy.S, "Operation research", 4th Edition, Vikas Publishing House, 2013 ISBN:978-93-259-6347-4	

Reference Books:

R1.A P Verma, "Operations Research", 7th edition, S K Kataria &Sons, , 2016(reprint)

R2.Paneerselvam, "Operations Research", 2nd edition, PHI, 2006.

R3.RA M Natarajan and P Balasubramani, "Operations Research", 4th impression, Pearson Education, 2009.

R4.Hiller and Liberman, "Introduction to Operations Research", 9th edition, McGraw Hill, 2012.

R5.RS.D. Sharma, "Operations Research", Ledarnath Ramanath & Co, 2002.

R6.Mitsuo Gen & Runwei Cheng, "Genetic Algorithm and engineering Design", 1997 Edition, A Wiley- Interscience Publication, ISBN:0-471-12741-8

Online Resources:

NIL

Course Name: Product Design and Development					
Course Code : RM831E2					
	L	**T**	**P**	**Category**	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	**CIA Marks**	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	**ESE Marks**	**50**
Credits.	**3**	**0**	**0**	**Exam Hours**	**3 Hrs**

Course objectives:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability.

Prerequisites: Basic Knowledge in Manufacturing process, cist and estimation of manufacturing process

Units	**Teaching Hours**
Unit-1	
INTRODUCTION TO PRODUCT DESIGN: Asimow's model: Definition of product design - Design by evolution - Design by innovation - Essential factors of Product design - Production-Consumption cycle - Flow and value addition in the Production-Consumption cycle, **THE MORPHOLOGY OF DESIGN**: (The seven phases) - Primary design phases and flowcharting - Role of allowance - Process capability and Tolerance in detailed design & assembly.	9
Unit-2	
PRODUCT DESIGN PRACTICE AND INDUSTRY: Introduction - Product Strategies - Time to Market - Analysis of the product - The S's Standardization - Renard Series – Simplification - Role of Aesthetics in Product Design - Functional Design Practice. **REVIEW OF STRENGTH, STIFFNESS AND RIGIDITY CONSIDERATIONS IN PRODUCT DESIGN:** Principal stress trajectories (Force-Flow lines) - Balanced design - Criteria and objectives of Design - Material Toughness: Resilience designing for uniform strength - Tension vis-à-vis Compression. Review of production processes - Machining processes - Non-Traditional machining Processes.	9
Unit-3	

DESIGN FOR PRODUCTION-METAL PARTS: Producibility requirements in the Design of machine components design - Forging design - Pressed component design - Casting design - Design for machining ease - The role of process engineer - Ease of location casting and special casting. Designing with plastic rubber, ceramics and wood: Approach to design with plastics - plastic bush bearings - gears in plastics - rubber parts - design recommendations for rubber parts - ceramic and glass parts. **OPTIMIZATION IN DESIGN:** Introduction - Siddal's classification of design approach - Optimization by differential calculus - Legrange Multipliers - Linear programming (Simplex Method) - Geometric programming - Johnson's method of optimum design.	9
Unit-4	
ECONOMIC FACTOR INFLUENCING DESIGN: Product Value - Design for safety - Reliability and environmental considerations - Manufacturing operations in relation to Design - Economic analysis - Profit and Competitiveness - Break-Even analysis - Economic of a new product design. **HUMAN ENGINEERING CONSIDERATION IN PRODUCT DESIGN:** Introduction - Human being as applicator of forces - Anthropometry; Man as occupant of space - The design of controls - The design of displays - Man/Machine information exchange.	9
Unit-5	
VALUE ENGINEERING AND PRODUCT DESIGN: Introduction - Historical perspective - What is value? Nature and measurement of value - Normal degree of value - Importance of value - the value analysis job plan – creativity - Steps to problem-solving and value analysis - Value analysis test - Value engineering idea generation check-list cost reduction through value engineering case study on Tap switch control assembly. **MATERIAL AND PROCESS SELECTION IN VALUE ENGINEERING:** Modern approach to product design: Concurrent design and Quality function deployment (QFD).	9
Self-study :	
Site/Industrial Visits :	

Course outcomes:

CO1: Identify and analyse the product design and development processes in manufacturing industry.(L1, L2)(PO1,PO2,PO8,PO9)

CO 2: Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.(L1, L2)(PO1,PO2,PO8)

CO 3: Analyse, evaluate and apply the methodologies for product design, development and management.(L1, L2, L3, L4, L5)(PO1,PO2,PO3,PO4,PO5,PO8,PO9)

CO 4: Carry out cost and benefit analysis through various cost models.(L1, L2, L3, L4, L5)(PO1,PO2,PO3,PO4,PO5,PO8,PO9)

CO 5: Be familiar with the design protection and Intellectual Property.(L1, L2)(PO1,PO2)

Text Books:

1. A.C. Chitale and R.C. Gupta, "Product Design and Manufacturing, 6 th edition, PHI, 2011.

2. Karl T.Ulrich & Steven D, Epinger, "Product Design & Development", 4th edition, Tata Mc. Graw Hill, 2007.

Reference Books:

1. Tim jones, Butterworth Heinmann, "New Product Development", Oxford, mc 1997.

2. Roland EngeneKinetovicz, "New Product Development: Design & Analysis" John

Wiley and Sosn Inc., N.Y.1990.

Online Resources:

W1. NPTEL course (IIT Roorke)

Course Name: Industrial Engineering					
Course Code: RM831E3					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: To understand various fundamental disciplines of management like personnel management, marketing management, financial management etc. To apply this basic knowledge to understand the working of corporate world.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
Principles of management Concepts of management, development of scientific management, principles of Fredric Taylor & functions such as planning organizing , staffing, leading motivating, communicating, controlling, decision making, span of control	**9**
Unit-2:	
Personal management Meaning, functions of personal management, manpower planning, collective bargaining, wages & salary administration, labor welfare, training, trade unions, industrial factories Act, industrial boilers Act, Trade union act.	**9**
Unit-3:	
Plant management Plant location, plant layout, types of maintenance such as break down, predictive & preventive maintenance, stores of management, industrial safety, causes & cost of accidents, safety programs, production planning & control, job, batch & process type of production	**9**
Unit-4:	
Marketing management Definition & selling & modern concept of marketing, market research, new product development, product life cycle product launching, sales promotion, pricing, channels of distribution, advertising, market segmentation, marketing mix.	**9**
Unit-5:	
Material management Importance of material management, classification, codification, forecasting, necessity of inventory Financial management Sources of finance, financing organizations, types of capital, elements of costs & allocation of indirect expenses, cost control, break even analysis, budgets & budgetary control, equipment replacement policy, make or buy analysis, balance sheet, ratio analysis, profit & loss statement.	**9**

Self-study: NIL

Site/Industrial Visits: NIL
Course outcomes: • CO1: Describe the principles of management and concepts of management. {L1} {PO1} • CO2: Explain the personal management and its functions{L2} {PO2} • CO3:. Understand the Concepts of plant management{L2} {PO2} • CO4: elaborate marketing management and product life cycle. {L2} {PO2} • CO5: Illustrate the material and financial management guidelines{L2} {PO2}
Text Books: T1. Banga T.R.,.Sharma "Industrial organization & engineering Economics"; S.C. Edition Khanna Pub. T2 Kotler P., Stauton William "Principles of marketing management", 5th Ed.; PrenticeHall, 1985
Reference Books:
Online Resources:

Course Name: Safety Engineering					
Course Code: RM831E4					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- To know the safety rules and regulations, standards and codes
- To study various mechanical machines and their safety importance
- To understand the principles of machine guarding and operation of protective devices.
- To know the working principle of mechanical engineering processes such as metal forming and joining process and their safety risks.
- Developing the knowledge related to health and welfare measures in engineering industry

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electric	**9**
Unit-2:	
PRINCIPLES OF MACHINE GUARDING Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses-forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.	**9**
Unit-3:	
SAFETY IN WELDING AND GAS CUTTING Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.	**9**
Unit-4:	

SAFETY IN COLD FARMING AND HOT WORKING OF METALS Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.	**9**
Unit-5:	
SAFETY IN FINISHING, INSPECTION AND TESTING Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry, industrial waste disposal.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: • CO1: Students can have the knowledge in safety rules, standards and codes in various mechanical engineering processes. {L1} {PO1} • CO2:. They can design machine guarding systems for various machines such as lathe, drilling, boring, milling etc.,{L2} {PO2} • CO3:. They can implement the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes etc.,{L3} {PO2} • CO4: Students will have knowledge in testing and inspection as per rules in boilers, heat treatment operations etc.,{L3} {PO2} • CO5: Students will have knowledge in testing and inspection as per rules in boilers, heat treatment operations etc., {L2} {PO2} • CO6: They can take preventive measures in health and welfare of workers' aspects in engineering industry. {L2} {PO2}	
Text Books: T1. Heinrich H. W, "Industrial accident prevention", McGraw Hill Company, New York, 1980 T2. Frank P. Lees, "Loss prevention in process industries", Vol. I, II & III, Butterworth, London, 1980 T3. Brown D. B, "System analysis and design for safety" Prentice Hall, New Jercy, 1976 1. "Accident Prevention Manual" – NSC, Chicago, 1982. 2. "Occupational safety Manual" BHEL, Trichy, 1988. 3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.	

Reference Books:

R1. Derek James, "Fire prevention hand book", Butter Worths and Company, London, 1986

R2. "Accident prevention manual for industrial operations", National Safety Council, Chicago, 1989

R3. Clayton and Clayton, "Patty's industrial hygiene and toxicology", Vol. I, II & III, Wiley Interscience

4. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996. 5. Indian Boiler acts and Regulations, Government of India. 6. Safety in the use of wood working machines, HMSO, UK 1992. 7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

Online Resources:

Course Name: System modelling and simulation					
Course Code: RM831E5					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- Explain the basic system concept and definitions of system;
- Discuss techniques to model and to simulate various systems;
- Analyze a system and to make use of the information to improve the performance.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation Simulation examples: Simulation of queuing systems. General Principles, Simulation Software:Concepts in Discrete-Event Simulation. The Event-Scheduling / Time-Advance Algorithm, Manual simulation Using Event Scheduling	**9**
Unit-2:	
Statistical Models in Simulation :Review of terminology and concepts, Useful statistical models,Discrete distributions. Continuous distributions,Poisson process, Empirical distributions. Queuing Models:Characteristics of queuing systems,Queuing notation,Long-run measures of performance of queuing systems,Long-run measures of performance of queuing systems cont…,Steady-state behavior of M/G/1 queue, Networks of queues,	**9**
Unit-3:	
Random-NumberGeneration:Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers,Tests for Random Numbers, Random-Variate Generation: ,Inverse transform technique Acceptance-Rejection technique.	**9**
Unit-4:	
Input Modeling: Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models. Estimation of Absolute Performance: Types of simulations with respect to output analysis ,Stochastic nature of output data, Measures of performance and their estimation,	**9**
Unit-5:	

Measures of performance and their estimation, Output analysis for terminating simulations Continued, Output analysis for steady-state simulations. Verification, Calibration And Validation: Optimization: Model building, verification and validation, Verification of simulation models, Verification of simulation models,Calibration and validation of models, Optimization via Simulation.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: • CO1: Explain the system concept and apply functional modeling method to model the activities of a static system. {L1} {PO1} • CO2: Describe the behavior of a dynamic system and create an analogous model for a dynamic system; {L2} {PO2} • CO3: Simulate the operation of a dynamic system and make improvement according to the simulation results. {L3} {PO2} •	
Text Books: T1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5 th Edition, Pearson Education, 2010.	
Reference Books: R1. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006. R2. Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGrawHill, 2007	
Online Resources:	

Course Name: Hybrid vehicles					
Course Code: RM832E1					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: To understand the principles of traction To understand the characteristics of hybrid vehicles• To differentiate various motors and drives• To integrate various subsystems• To understand energy conservation principles in hybrid vehicles•

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
HYBRID VEHICLES: History and importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Basics of vehicle performance, vehicle power sources, transmission characteristics, and mathematical models to describe vehicle performance.	**9**
Unit-2:	
HYBRID TRACTION: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Basic concepts of electric traction, introduction to various electric drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	**9**
Unit-3:	
MOTORS AND DRIVES: Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	**9**
Unit-4:	
INTEGRATION OF SUBSYSTEMS: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems	**9**
Unit-5:	
ENERGY MANAGEMENT STRATEGIES: Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.	**9**
Self-study: NIL	

Site/Industrial Visits: NIL

Course outcomes:

- CO1: To understand concepts of hybrid and electric drive configuration, types of electric machines that can be used, suitable energy storage devices etc. {L1} {PO1}
- CO2: To recognize the application of various drive components and selection of proper component• for particular applications. {L2} {PO2}

Text Books:

T1. Bimal K. Bose, „Power Electronics and Motor drives" , Elsevier, 2011

T2. Iqbal Hussain, „Electric and Hybrid Vehicles: Design Fundamentals", 2nd edition, CRC Pr I Llc, 2010 T3 Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013

Reference Books:

R1. Sira -Ramirez, R. Silva Ortigoza, „Control Design Techniques in Power Electronics Devices", Springer, 2006

R2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, „Sliding mode control of switching Power Converters", CRC Press, 2011

R3. Ion Boldea and S.A Nasar, „Electric drives", CRC Press, 2005

Online Resources:

Course Name: IOT and Cyber physical Systems					
Course Code: RM832E2					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: This course introduces the basic concepts of IoT, the functionalities of different types of sensors, actuators and micro controllers. It covers the protocols used in different layers and gives insight on programming IoT for different domains.

Prerequisites: Computer Networks,Basics of Programming

Units	**Teaching Hours**
Unit-1:	
INTRODUCTION AND BACKGROUND: 1 Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, Logical Design of IoT: IoT functional Blocks, IoT Communication Blocks, IoT communication APIs, IoT Enabling Technologies: WSN, Cloud Computing, Big Data Analysis, Communication Protocols, Embedded Systems.	**9**
Unit-2:	
IOT HARDWARE, DEVICES AND PLATFORMS: Basics of Arduino: The Arduino Hardware, The Arduino IDE, Basic Arduino Programming, Basics of Raspberry pi: Introduction to Raspberry Pi, Programming with Raspberry Pi, CDAC IoT devices: Ubimote, Wi-Fi mote, BLE mote, WINGZ gateway, Introduction to IoT Platforms, IoT Sensors and actuators.	**9**
Unit-3:	
IOT PROTOCOLS: Arduino Programming: Serial Communications, Getting input from sensors, Visual, Physical and Audio Outputs, Remotely Controlling External Devices, Wireless Communication. Programming with Raspberry Pi: Basics of Python Programming, Python packages of IoT, IoT Programming with CDAC IoT devices.	**9**
Unit-4:	
IOT PROGRAMMING: Arduino Programming: Serial Communications, Getting input from sensors, Visual, Physical and Audio Outputs, Remotely Controlling External Devices, Wireless Communication. Programming with Raspberry Pi: Basics of Python Programming, Python packages of IoT, IoT Programming with CDAC IoT devices	**9**
Unit-5:	
DOMAIN SPECIFIC IOT: Home automation, Smart cities, Smart Environment, IoT in Energy, Logistics, Agriculture, Industry and Health & Life style secors. Case Studies: A Case study of Internet of Things Using Wireless Sensor Networks and Smartphones, Security Analysis of Internet-of-Things: A Case Study of August Smart Lock, OpenIoT platform.	**9**

Self-study: NIL

Site/Industrial Visits: NIL

Course outcomes:

- CO1: Explain the fundamental building blocks of an IoT environment from a logical and physical perspective.{L1} {PO1}
- CO2:. Summarize various IoT protocols in Application and Network layers by outlining their advantages and disadvantages{L2} {PO2}
- CO3:. Develop programing skills to design IoT solutions using Arduino and Raspberry Pi to solve real life problems{L3} {PO2}
- CO4: Experiment with Arduino, CDAC, and Raspberry Pi to choose the appropriate hardware for different IoT projects.{L3} {PO2}
- CO5: Survey successful IoT products and solutions to analyze their architecture and technologies.{L2} {PO2}

Text Books:

T1. Vijay Madisetti and ArshdeepBahga, ―Internet of Things (A Hands-on-Approach)‖, 1st Edition, VPT, 2014.

T2 Margolis, Michael. ―Arduino Cookbook: Recipes to Begin, Expand, and Enhance Your Projects. " O'Reilly Media, Inc.", 2011.

T3 Monk, Simon. Raspberry Pi cookbook: Software and hardware problems and solutions. " O'Reilly Media, Inc.", 2016.

Reference Books:

R1. The Internet of Things: Applications to the Smart Grid and Building Automation by – Olivier Hersent, Omar Elloumi and David Boswarthick – Wiley Publications -2012.

R2. Honbo Zhou, ―The Internet of Things in the Cloud: A Middleware Perspective‖, CRC Press, 2012.

R3. David Easley and Jon Kleinberg, ―Networks, Crowds, and Markets: Reasoning About a Highly Connected World‖, Cambridge University Press, 2010.

Online Resources:

Course Name: Biomedical signal processing					
Course Code: RM832E3					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:
Apply knowledge of math, engineering and science to understand the principle of biomedical signal processing. Understand how to apply specific mathematical techniques to solve problems in the areas of biomedical signals (e.g., calculation of an ECG spectrum using Fourier Series and calculation of Heart Rate Variability using Fourier Transforms).

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
INTRODUCTION TO BIOMEDICAL SIGNALS: Examples of Biomedical signals - ECG, EEG, EMG etc - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments	**9**
Unit-2:	
CONCURRENT, COUPLED AND CORRELATED PROCESSES: Illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle- contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.	**9**
Unit-3:	
CARDIO VASCULAR APPLICATIONS: Basic ECG - Electrical Activity of the heart-ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis Data	**9**
Unit-4:	

COMPRESSION: Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.	**9**
Unit-5:	
NEUROLOGICAL APPLICATIONS: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: • CO1: Analyze and extend the mathematical and physical foundations of biomedical engineering and how these are reproduced in the design of biomedical instruments, the analysis of biological systems, and the technological advancement {L3} {PO2} • CO2:. Explain the concepts of embedded systems{L2} {PO2} • CO3:. Understand the Concepts of peripherals and interfacing of sensors{L2} {PO1} • CO4: Capable of using the system design techniques to develop firmware {L3} {PO2} • CO5: Illustrate the code for constructing a system{L2} {PO5}	
Text Books: T1. D.C.Reddy ,"Biomedical Signal Processing: Principles and techniques" ,Tata McGraw Hill,New Delhi, 2005 T2 Willis J Tompkins , Biomedical Signal Processing -, ED, Prentice – Hall, 1998 T3 Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013	
Reference Books: R1. R. Rangayan, "Biomedical Signal Analysis", Wiley 2002. R2. Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2007 R3. Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier (2005) R4. Semmlow, "Bio-signal and Biomedical Image Processing", Marcel Dekker,2014 R5. Enderle, "Introduction to Biomedical Engineering," 2/e, Elsevier, 2005	
Online Resources:	
Course Name: Safety and Security of Automotive Systems	

Course Code: RM832E4					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives: To impart knowledge on the Building blocks of Embedded System, Various embedded Development Strategies, Bus Communication in processors, Input/output interfacing. processor scheduling algorithms.Basics of Real time operating system

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
INTRODUCTION Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction.	**9**
Unit-2:	
SAFETY CONCEPTS Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.	**9**
Unit-3:	
SAFETY EQUIPMENTS Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety.	**9**
Unit-4:	
COLLISION WARNING AND AVOIDANCE Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system interactions.	**9**
Unit-5:	
COMFORT AND CONVENIENCE SYSTEM Steering and mirror adjustment, central locking system , Garage door opening system, tyre pressure control system, rain sensor system, environment information system	**9**

Self-study: NIL

Site/Industrial Visits: NIL

Course outcomes:

- CO1:Understand and remember the fundamentals of safety during body design {L1} {PO1}
- CO2: Applying the knowledge for selecting the suitable active & passive systems {L2} {PO2}
- CO3: Applying the knowledge for selecting the suitable safety equipments for designing a vehicle {L3} {PO2}

- CO4: Creating the advanced system for increasing the safety in special purpose vehicles {L3} {PO2}

Text Books:

T1. Bosch - ―Automotive Handbook‖ - 5th edition - SAE publication - 2000.

T2 Vivek D. ―Ergonomics in the Automotive Design Process" Bhise publisher CRC press, Taylor and Francis group.

T3 Ronald K Jurgen, ―Automotive Electronics Handbook‖ - Second edition- McGraw-Hill Inc., - 1999.

T4 Jullian Happian, ―Smith An Introduction to Modern Vehicle Design‖, SAE, 2002.

Reference Books:

R1. Johnson W and Mamalis A.G, ―Crashworthiness of Vehicles‖, MEP, London.

R2. Richard Bishop, ―Intelligent Vehicle Technology and Trends‖ – 2005.

R3. George A. Peters , Barbara J. Peters, ―Automotive Vehicle Safety‖ – 2002.

Online Resources:

NIL

Course Name: Power Electronics					
Course Code: RM832E5					
	L	**T**	**P**	Category	**PEC**
Contact Hrs./Week	**3**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**	**0**	**0**	ESE Marks	**50**
Credits.	**3**	**0**	**0**	Exam Hours	**3**

Course objectives:

- To compare characteristics of switching devices.
- To evaluate the performance of phase controlled converters for different types of loads.
- To design DC-DC converters with given characteristics.
- To analyze and evaluate the operation of inverters.
- To identify different power quality issues due power electronic devices in the circuit and study of compensating devices to mitigate that.
- To experimentally verify the performance of various switching devices and circuits like rectifiers, voltage controller, choppers and inverters.

Prerequisites: Nil

Units	**Teaching Hours**
Unit-1:	
POWER SEMI-CONDUCTOR DEVICES, FIRING, COMMUTATION AND PROTECTION CIRCUITS . Structure, operation and characteristics of SCR, power transistor, MOSFET and IGBT.Two transistor analogy of SCR, Merits, Demerits and application of SCR ,Turn on and turn off methods of SCR, Turn on and turn off dynamic characteristics of SCR, Thyristor gate characteristics, Thyristor ratings, SCR firing circuits, UJT firing circuit, di/dt and dv/dt protection, snubber circuit and its numerical problems. Switching losses.	**9**
Unit-2:	
PHASE-CONTROLLED CONVERTERS 2-pulse, 3-pulse and 6-pulse converters – Their operation with R, RL and RLE and the effect of free wheeling diode, derivation of average and rms load voltage and its numerical problems - Effect of source inductance - Distortion and displacement factor – Ripple factor - Single phase AC voltage controllers ON-OFF control and phase control.	**9**
Unit-3:	
DC TO DC CONVERTERS Chopper- Time ratio control and current limit control strategy, classification based on voltage and current flow-class A, B, C, D, E types of chopper. Step up chopper and step down chopper – derivation of average and rms load voltage and load current Performance parameters of chopper and regenerative operation of step up chopper. Operation and design considerations of Buck, boost, buckboost converters.	**9**
Unit-4:	

INVERTERS Single phase and three phase (both 1200mode an d 1800mode) inverters - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM and multiple PWM - Voltage and harmonic control - Series resonant inverter - Current source inverters.	**9**
Unit-5:	
APPLICATIONS Uninterrupted power supply topologies - Flexible AC transmission systems - Static VAr compensators(SVC)-TCR,TSR,TSC, static synchronous compensators(STATCOM), comparison of shunt compensators, Static series compensators-TSSC, TCSC, GCSC, SSSC. Comparison of series compensators. Comparison of series and shunt compensators, IPFC and UPFC.	**9**
Self-study: NIL	
Site/Industrial Visits: NIL	
Course outcomes: • CO1: To describe the construction, design and characteristics of semiconductor devices. {L1} {PO1} • CO2: To describe the modes of operation of power electronic converters and inverters. {L2} {PO2} • CO3: To design and apply power electronic circuit for generalized requirement. {L3} {PO3} •CO4: To apply the knowledge of power electronics in power quality domain particularly for compensation. {L3} {PO3} • CO5: To experimentally verify the performance of various switching devices and circuits like rectifiers, voltage controller, choppers and inverters. {L4} {PO5}	
Text Books: T1. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", T2 Pearson Education, Third edition, 2004 / PHI. T3 Ned Mohan, Tore.M.Undeland, William. P. Robbins, "Power electronic converters, Application and Design" John Wiley and sons, third edition, 2013.	
Reference Books: R1. Bimal K. Bose, " Modern power electronics and ac drives", Pearson Edeucation.2013. R2. Mr.Jaganathan, " Introduction to power electronics", Prentice Hall of India,2004. R3. Bimbra P.S, " Khanna Publishers", Fifth edition.	
Online Resources: NIL	