Faculty of Engineering

Department of Mechanical Engineering

Syllabus for

B.Tech-Mechanical Engineering

(Printable BOS for Academic year 2018-19)

CHRIST (Deemed to be University), Bangalore,

Karnataka, India

www.christuniversity.in

Syllabus for BTech- Mechanical Engineering 2018-19 prepared by the Department of Mechanical Engineering, Faculty of Engineering and approved by the Academic Council, Christ (Deemed to be University), Bengaluru, India.

Published by the Centre for Publications, Christ (Deemed to be University), Hosur Road, Bengaluru 560 029, India. publications@christuniversity.in

2018

Index

INTRODUCTION

CHRIST (Deemed to be University), formerly CHRIST (Deemed to be University)College (Autonomous), was born out of the educational vision of St. Kuriakose Elias Chavara, an educationalist and a social reformer of the nineteenth century. He founded the first indigenous congregation, Carmelites of Mary Immaculate (CMI). Established in July 1969, Christ College became the most preferred educational institution in the city of Bengaluru within the first three decades. From 1990, it initiated path-breaking reforms in higher education with the introduction of innovative and modern curricula, insistence on academic discipline, imparting of Holistic Education and the support of creative and dedicated staff. Today CHRIST (Deemed to be University)University is rated among the top ten educational institutions of the country. The UGC conferred Autonomy to Christ College (No. F.13-1/2004) on 7 October 2004 and identified it as an Institution with Potential for Excellence in 2006. On 22July, 2008 under Section 3 of the UGC Act, 1956, the Ministry of Human Resources Development of the Union Government of India, vide Notification No. F. 9-34/2007-U.3 (A), declared it a Deemed to be University, in the name and style of CHRIST (Deemed to be University)University

"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)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

To develop Mechanical and Automobile Engineering professionals to be successful in chosen career through innovative academic processes for overall development, upholding integrity and ethics

MISSION STATEMENT

1. To create excellent academic facilities and provide quality teaching learning experience
2. To nurture holistic development of individuals for excellence and service with ethics

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S):

PEO-1: Provide students with the fundamental knowledge in basic science and engineering in the streams like Design, Thermal and Production engineering to recognize, analyze and solve problems to succeed in technical profession both in industry and higher studies

PEO-2: Provide students with the necessary instruction and practical experience to work well in a team and multi-disciplinary environments and to be effective in written and oral communicators, both for communicating ideas, mentoring, and for learning from others

.

PEO-3: Produce graduates who have an understanding of continuous learning, ethical responsibility and service toward their peers, employers, society and follow these precepts in their daily lives

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 EngineeringProgram 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. COURSE OFFERED

- **<u>Undergraduate Programmes (B. Tech in)</u>**
  B. Tech in-
  - Automobile Engineering (AE)
  - Civil Engineering(CIVIL)
  - Computer Science and Engineering (CSE)
  - Electronics and Communication Engineering (ECE)

- Electrical and Electronics Engineering (EEE)
- Information Technology (IT)
- **Mechanical Engineering (ME)**

- **Postgraduate Programmes** (M. Tech) (2 Years Program)
  - Master of Technology in Computer Science & Engg.
  - Master of Technology in Communication Systems
  - Master of Technology in Information Technology
  - **Master of Technology in Machine Design**
  - Master of Technology in Power Systems
  - Master of Technology in Structural Engineering
- **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 Eng.
  - 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

B.Tech-

- Pass in PUC (10+2) or equivalent with 50% marks in aggregate in Mathematics, Physics and Chemistry is the minimum eligibility for admission
- Lateral Entry Candidates who have successfully completed 3 years of diploma in Engineering or Bachelor of Science (as approved by AICTE) are eligible to apply for lateral entry into:
  - Automobile Engineering (AE)
  - BTech Civil Engineering, (CE)
  - **BTech Mechanical Engineering, (ME)**
  - BTech Computer Science & Engineering, (CSE)
  - BTech Electronics & Communication Engineering. (ECE)
  - BTech Electrical and Electronics Engineering (EEE)
  - BTech Information Technology (ITE

- **MTech**

  A Pass Class in B.Tech/B.E with 55% aggregate

Candidates will be admitted to second year of the programme only after appearing the CHRIST (Deemed to be University)University selection process for engineering programmes.

❖ **For Postgraduate Programmes**:

- For Master of Technology in Computer Science & 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/BTech or M.Sc in Civil and VLSI Design with 55% aggregate.
- **For Master of Technology in Mechanical Engineering**
    - A Pass in BE/BTech.with 55% aggregate.

❖ **<u>For Doctoral Programmes (Ph.D.):</u>**

- 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 (Deemed to be University)University Selection Process as given below:

Process	Particulars	Date	Venue/Centre
Entrance Test	CHRIST (Deemed to be University)University 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)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)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 2012
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.

$$\text{GPA} = \frac{\sum[\text{GPAxCr}]}{\sum \text{Cr}}$$

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

9. COURSE 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. COURSE 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

Our teaching methodology ensures that students are being exposed to a holistic education experience in an active and dynamic learning environment, giving them the opportunity to identify and realize their potential, and to achieve excellence. In order to realize the objectives, a methodology based on the combination of the following will be adopted:

1. Team/Class room teaching.
2. PowerPoint presentations and handouts.
3. Simulated situations and role-plays.
4. Video films on actual situations.
5. Assignments.
6. Case Studies.
7. Exercises are solved hands on.
8. Seminars
9. Industry / Field visits.
10. Information and Communication Technology.
11. Project work.
12. Learning Management System.

12. DETAILS OF ASSESSMENT

	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**	**Minimum marks to pass**	**Maximum marks**	**Component**	**Assessed for**	**Scaled down to**	**Minimum marks to pass**	**Maximum 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

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

CIA 100 MARKS						**ESE 100 MARKS**
Review 1		**Review 2**		**Review 3**		
REVIEW COMMITTEE	GUIDE	REVIEW COMMITTEE	GUIDE	REVIEW COMMITTEE	GUIDE	EXAMINERES
20	05	20	10	20	25	**100**
TOTAL	**25**	**TOTAL**	**30**	**TOTAL**	**45**	

before the committee constituted by the Department
- The total marks obtained in the 3 reviews shall be 100 marks.

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 - Computer Aided : 40 marks
- Development of surfaces and Isometric Projections - Computer Aided : 30 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 instill 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	Marks	Credit
1	XX831	Elective V	100	4
2	XX832	Elective VI	100	4
3	XX833	Elective VII	100	4
4	XX871	Project Work	200	6
5	XX872	Comprehension	50	2
6	BTCY01	Cyber security		2
7	IC	The Constitution of India		1
		Total	550	23

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

The scheme shall call for the mandatory core course (Elective I, II, III) 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 and comprehension as 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:

I SEMESTER – CHEMISTRY CYCLE

Sl.	Course No.	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA131	Mathematics – I	3	1	0	100	3	1	0	4
2	CH132	Applied Chemistry	3	1	2	100	2	1	1	4
3	EC133	Basic Electronics	3	1	2	100	2	1	1	4
4	CS134	Basics of Computer Science and Engineering	3	1	2	100	2	1	1	4
5	ME135	Basics of Mechanical Engineering and Nano Science	3	1	0	100	3	0	0	3
6	ME 151	Workshop Practice	0	0	2	50	0	0	1	1
7	HE171	Holistic Education-I	1	0	0	---	1			1
		TOTAL	**16**	**5**	**8**	**550**	**13**	**4**	**4**	**21**

I SEMESTER – PHYSICS CYCLE

Sl.	Course No.	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA131	Mathematics – I	3	1	0	100	3	1	0	4
2	PH132	Applied Physics	3	1	2	100	2	1	1	4
3	EE133	Basics of Electrical Engineering	3	1	2	100	2	1	1	4
4	CE134	Basics of Civil Engineering & Engineering Mechanics	3	1	2	100	2	1	1	4
5	EG135	Engineering Graphics	2	2	0	100	2	2	0	4
6	PD136	Professional Development-I	3	1	0	100	2	1	0	3
7	HE171	Holistic Education-I	1				1	0	0	1

		TOTAL	**18**	**7**	**6**	**600**	**14**	**7**	**3**	**24**

II SEMESTER – CHEMESTRY CYCLE

Sl.	Course No.	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA231	Mathematics – II	3	1	0	100	3	1	0	4
2	CH232	Applied Chemistry	3	1	2	100	2	1	1	4
3	EC233	Basic Electronics	3	1	2	100	2	1	1	4
4	CS234	Basics of Computer Science and Engineering	3	1	2	100	2	1	1	4
5	ME235	Basics of Mechanical Engineering and Nano Science	3	1	0	100	3	0	0	3
6	ME 251	Workshop Practice	0	0	2	50	0	0	1	1
7	HE271	Holistic Education-I	1	0	0	---	1			1
		TOTAL	**16**	**5**	**8**	**550**	**13**	**4**	**4**	**21**

II SEMESTER – PHYSICS CYCLE

Sl.	Course No.	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA231	Mathematics – II	3	1	0	100	3	1	0	4
2	PH232	Applied Physics	3	1	2	100	2	1	1	4
3	EE233	Basics of Electrical Engineering	3	1	2	100	2	1	1	4
4	CE234	Basics of Civil Engineering & Engineering Mechanics	3	1	2	100	2	1	1	4
5	EG235	Engineering Graphics	2	2	0	100	2	2	0	4
6	PD236	Professional Development-I	3	1	0	100	2	1	0	3
7	HE271	Holistic Education-I	1	0	0	-	1	0	0	1
		TOTAL	**18**	**7**	**6**	**600**	**14**	**7**	**3**	**24**

SEMESTER III

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA 331	Mathematics –III	3	0	0	100	3	0	0	3
2	ME 332	Material Science and Metallurgy	3	0	0	100	3	0	0	3
3	ME 333	Basic Thermodynamics	3	0	0	100	3	0	0	3
4	ME 334	Strength of Materials	3	1	2	100	3	0	1	4
5	ME 335	Non-Conventional Energy Resources	3	1	2	100	3	0	1	4
6	ME 336	Professional Development II	3	0	0	100	3	0	0	3
7	ME 351	Foundry and Forging Lab	0	0	2	50	0	0	2	2
8	HE 371	Holistic Education-III	1	0	0	----	1	0	0	1
		TOTAL	**19**	**2**	**6**	**650**	**19**	**0**	**4**	**23**

SEMESTER IV

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA 431	Mathematics-IV	3	0	0	100	3	0	0	3
2	ME 432	Applied Thermodynamics	3	1	0	100	3	0	0	3
3	ME 433	Kinematics of Machines	3	0	0	100	3	0	0	3
4	ME 434	Primary Manufacturing	3	0	2	100	3	0	1	4
5	ME 435	Fluid Mechanics	3	0	2	100	3	0	1	4
6	ME 436	Engineering Metrology	3	0	2	100	3	0	1	4
7	ME 437	Computer Aided Machine Drawing	2	4	0	100	2	2	0	4
8	HE 471	Holistic Education-IV	1	0	0	---	1	0	0	1
		TOTAL	**21**	**5**	**6**	**700**	**21**	**2**	**3**	**26**

SEMESTER V

Sl. No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	ME 531	Design of Machine Elements	3	0	0	100	3	0	0	3
2	ME 532E	**Elective-I(Core)**	3	0	0	100	3	0	0	3
3	ME 533	Dynamics of Machinery	3	0	0	100	3	0	0	3
4	ME 534	Turbo Machines	3	0	2	100	3	0	1	4
5	ME 535	Internal Combustion Engines	3	0	2	100	3	0	1	4
6	ME 536	Advanced Manufacturing Technology	3	0	0	100	3	0	0	3
7	ME 551	Simulation Laboratory	0	0	2	50	0	0	2	2
		TOTAL	**18**	**0**	**6**	**650**	**18**	**0**	**4**	**22**

SEMESTER VI

Sl. No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	ME 631	Design of Transmission System	3	0	0	100	3	0	0	3
2	ME 632	Heat and Mass Transfer	3	1	2	100	3	0	1	4
3	ME 633	Finite Element Methods	3	0	2	100	3	0	1	4
4	ME 634	Mechatronics and Microprocessor	3	0	0	100	3	0	0	3
5	ME 635	Hydraulic and Pneumatic Control	3	1	2	100	3	0	1	4
6	XX	Elective-II(Open)	3	0	0	100	3	0	0	3
		TOTAL	**18**	**2**	**6**	**600**	**18**	**0**	**3**	**21**

SEMESTER VII

Sl. No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	ME 731	Engineering Economics	3	0	0	100	3	0	0	3
2	ME 732	Mechanical Vibrations	3	0	0	100	3	0	0	3
3	ME 733	Operations Research	3	0	0	100	3	0	0	3
4	ME 734	Mechatronics and Microprocessor	3	0	0	100	3	0	0	3
5	ME 735E	Elective-III(Core)	3	0	0	100	3	0	0	3
6	XX	Elective- IV(Humanities)	2	0	0	50	2	0	0	2
7	ME 751	Design Laboratory	0	0	2	50	0	0	2	2
8	ME 752	Heat and Mass Transfer Laboratory	0	0	2	50	0	0	2	2
9	ME 753	Simulation Lab	0	0	2	50	0	0	2	2
10	ME771	Service Learning	0	0	2	50	0	0	2	2
11	ME872	Internship	0	0	4	-	0	0	2	2
		TOTAL	**17**	**0**	**12**	**650**	**17**	**0**	**10**	**27**

SEMESTER VIII

Sl.No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	ME 831	Control Engineering	3	0	0	100	3	0	0	3
2	ME 832E	Elective-V(Core)	3	0	0	100	3	0	0	3
3	ME 833E	Elective-VI(Core)	3	0	0	100	3	0	0	3
4	ME 871	Project Work	0	0	12	200	0	0	6	6
5	ME 872	Comprehension	0	0	2	50	0	0	2	2
7	BTCY01	Cyber Security	2	0	0	--	2	0	0	2
8	IC	Constitution of India	1	0	0	--	1	0	0	1
		TOTAL	**12**	**0**	**14**	**550**	**12**	**0**	**8**	**20**

ELECTIVE-I

Sl No	Course No	Course Name	HOURS			TOTAL MARKS	CREDITS			TOTAL CREDITS
			L	T	P		L	T	P	
1	ME532E1	Project Management	3	0	0	100	3	0	0	3
2	ME532E2	Non Traditional Machining	3	0	0	100	3	0	0	3
3	ME532E3	Composite Materials	3	0	0	100	3	0	0	3
4	ME532E4	Refrigeration and Air Conditioning	3	0	0	100	3	0	0	3
5	ME532E5	Energy Engineering	3	0	0	100	3	0	0	3
6	ME532E6	Theory of Elasticity	3	0	0	100	3	0	0	3
7	ME532E7	Non Destructive Testing	3	0	0	100	3	0	0	3
8	ME532E8	Knowledge Management	3	0	0	100	3	0	0	3
9	ME532E9	Statistical Quality Control	3	0	0	100	3	0	0	3
10	ME532E10	Micro and Smart System Technology	3	0	0	100	3	0	0	3

ELECTIVE-III

Sl No	Course No	Course Name	HOURS			TOTAL MARKS	CREDITS			TOTAL CREDITS
			L	T	P		L	T	P	
1	ME735E1	Cryogenics	3	0	0	100	3	0	0	3
2	ME735E2	Gas Dynamics and Space Propulsion	3	0	0	100	3	0	0	3
3	ME735E3	Power Plant Engineering	3	0	0	100	3	0	0	3
4	ME735E4	Theory of Elasticity	3	0	0	100	3	0	0	3
5	ME735E5	Experimental Stress Analysis	3	0	0	100	3	0	0	3
6	ME735E6	Design of Experiments	3	0	0	100	3	0	0	3
7	ME735E7	Organizational Behavior & Professional Ethics	3	0	0	100	3	0	0	3
8	ME735E8	Total Quality Management	3	0	0	100	3	0	0	3

ELECTIVE-V

Sl No	Course No	Course Name	HOURS			TOTAL MARKS	CREDITS			TOTAL CREDITS
			L	T	P		L	T	P	
1	ME832E1	Smart Materials	3	0	0	100	3	0	0	3
2	ME832E2	Product Design & Manufacturing	3	0	0	100	3	0	0	3
3	ME832E3	Nano Technology	3	0	0	100	3	0	0	3
4	ME832E4	Composite Materials	3	0	0	100	3	0	0	3
5	ME832E5	Tribology	3	0	0	100	3	0	0	3
6	ME832E6	Computer Graphics	3	0	0	100	3	0	0	3
7	ME832E7	Computational Fluid Dynamics	3	0	0	100	3	0	0	3
8	ME832E8	Non-conventional Energy Resources	3	0	0	100	3	0	0	3

ELECTIVE-VI

Sl No	Course No	Course Name	HOURS			TOTAL MARKS	CREDITS			TOTAL CREDITS
			L	T	P		L	T	P	
1	ME833E1	Supply Chain Management	3	0	0	100	3	0	0	3
2 3	ME833E2 ME833E3	Rapid Prototyping Flexible Manufacturing System	3	0	0	100	3	0	0	3
4	ME833E4	Fracture Mechanics	3	0	0	100	3	0	0	3
5 6	ME833E5 ME833E6	Synthesis of Mechanism Gas Turbine and Jet Propulsion	3	0	0	100	3	0	0	3
7	ME833E7	Energy Engineering	3	0	0	100	3	0	0	3
9	ME833E8	Internet of Things	3	0	0	100	3	0	0	3

OPEN ELECTIVES OFFERED BY THE DEPARTMENT										
Sl.No	**Course No**	**Course Name**	**Hours**			**Marks**	**Credits**			**Total Credits**
			L	**T**	**P**		**L**	**T**	**P**	
1	ME63OE01	Green Belt Practice	3	0	0	100	3	0	0	3
2	ME63OE02	Facility Planning and Design	3	0	0	100	3	0	0	3
3	ME63OE03	Basic Automobile Engineering	3	0	0	100	3	0	0	3
4	ME63OE04	Project Management	3	0	0	100	3	0	0	3
5	ME63OE05	Basic Aerospace Engineering	3	0	0	100	3	0	0	3
6	ME63OE06	Industrial Robotics	3	0	0	100	3	0	0	3
7	ME63OE07	Non Destructive Testing	3	0	0	100	3	0	0	3
8	ME63OE08	Energy and Environment	3	0	0	100	3	0	0	3
9	ME63OE09	Alternative Energy Sources for Automobiles	3	0	0	100	3	0	0	3
10	ME63OE10	Hybrid and Electric Vehicle	3	0	0	100	3	0	0	3

SEMESTER I

MATHEMATICS I

(Common for all branches)

Sub Code: MA131	**L:T:P**	**Total Lecture Hrs :60**
Exam Marks: 100	**Hrs/week : 3:1:0**	**Exam Hours : 03**

COURSE DESCRIPTION:

This paper contains five units which are Linear Algebra, Differential and Integral Calculus, Differential Equation and Vector Calculus. This paper aims at enabling the students to know numerical techniques of solving system of equations, various concepts of calculus of functions of several variables, application of calculus to find area, volume etc and drawing complicated curves, classification of different type of differential equation with an introduction to vector calculus are covered in this paper.

COURSE OBJECTIVE:

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.

COURSE OUTCOMES:

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

Unit I: Linear Algebra **10 Hrs**

Fundamental concepts of Matrix, Rank of a Matrix, Consistency of the system of equations, Solution of linear simultaneous equations: - Gauss elimination and Gauss Jordan methods. Gauss – Seidel iterative method.

Eigen values and Eigen Vectors, Diagonalization, Computation of largest eigen value and the corresponding eigenvector by Rayleigh's power method.

Unit II: Differential Calculus - I **12 Hrs**

Partial Differentiation: Partial derivatives, Euler's theorem. Total differential coefficient,

differentiation of composite and implicit functions, Jacobians and properties. Leibnitz's Rule of differentiation under integral sign.

UNIT - III: Integral Calculus – I **14 Hrs**

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. Tracing of standard curves in Cartesian, Parametric and Polar form.

Derivative of arc length, Applications of integration to find surfaces of revolution and volumes of solids of revolution.

UNIT – IV: Differential Equation - I **12 Hrs**

Solution of first order and first degree differential equations: Reducible to Homogeneous, Linear and Exact differential equation, Applications of differential equations. orthogonal trajectories.

UNIT –V: Vector Calculus - I **12 Hrs**

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.

TEXT BOOKS

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

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, Inc, 2005
2. Thomas and Finney, "Calculus", 9th Edition, Pearson Education, 2004
3. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Publication, Canada, 2007
4. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw – Hill, 2009.
5. Michael Artin, "Algebra", 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2002
6. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2002
7. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006.
8. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005.

9. K. A. Stroud, "Engineering Mathematics", 5th Edition, Industrial Press, 2001.

APPLIED CHEMISTRY

(Common for all branches)

Sub Code: CH132/CH2321	L:T:P	Total Lecture Hrs :55
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

PAPER DESCRIPTION:

This paper contains five units which are Chemical Energy Sources, Electrochemical Energy Systems, Corrosion Science, Surface Chemistry & catalysis and Water Technology

This paper aims at enabling the students to know various energy sources. Corrosion and its control, Basics of surface chemistry and their application in catalysis, water technology and instrumental analysis.

COURSE OBJECTIVES:

- To describe the students on application oriented themes like the chemistry of materials used in engineering discipline
- To describe the students on the chemistry of compounds resulting from pollution, waste generation and environmental degradation and to apply the knowledge in solving these current environmental problems effectively.

COURSE OUTCOMES:

- Students will gain an understanding of oxidation and reduction reactions as they relate to engineering applications, such as corrosion.
- Students will understand the importance of Surface chemistry and Industrial catalysis and also they will recognize few characterization techniques in Material Sciences.
- Will understand the design and development of Photovoltaic devices.
- Will be understanding some Instrumental methods of analysis.

LEVEL OF KNOWLEDGE: *Basic*

Unit – I:

Chemical Energy Sources **10 Hours**

Introduction to energy; Fuels - definition, classification, importance of hydrocarbons as fuels; Calorific value-definition, Gross and Net calorific values (SI units).Ultimate and proximate analysis of fuel, Determination of calorific value of a solid / liquid fuel using Bomb calorimeter.Petroleum cracking-fluidised catalytic cracking.Reformation of petrol. Knocking - mechanism, octane number, cetane number, prevention of knocking, anti-knocking agents, unleaded petrol; synthetic petrol – Bergius process and Fischer Tropsch process; power alcohol.Solar Energy : Photovoltaic cells- Introduction, definition,

importance, working of a PV cell; solar grade silicon, physical and chemical properties of silicon relevant to photovoltaics, production of solar grade (crystalline) silicon and doping of silicon.

Unit – II:

Electrochemical Energy Systems (Electrode potential and cells) **8 Hours**

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.

Conversion and Storage of Electrochemical Energy 7 Hours

Battery Technology - Batteries-Basic concepts, battery characteristics. Classification of batteries –primary, secondary and reserve batteries. Classical Batteries–Construction working and applications of Zn–air, Nickel-Metal hydride and Lithium-MnO_2 batteries, Fuel Cells **-** Introduction, types of fuel cells-Alkaline, Phosphoric acid and Molten carbonate fuel cells. Solid polymer electrolyte and solid oxide fuel cells. Construction and working of $H_2O_2$and Methanol-Oxygen fuel cell

Unit III

Corrosion Science 10 Hours

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, Tafel Plot.

Unit – IV

Surface chemistry & Catalysis 8 hours

Introduction, Adsorption, Cause of adsorption, Basic terms in adsorption, Characteristics of adsorption (Variation of thermodynamic variables), Classification of adsorption, Effect of parameters on adsorption (Temperature, pressure, porosity, nature of gases), Adsorption isotherms, Catalysis, classification, types of catalysts (Acid and base catalysts), preparation methods (precipitation, co-precipitation, sol-gel and hydrothermal techniques), Kinetics of catalytic reactions, Applications-Catalytic activity.

Unit – V

Water Technology: 7 Hours

Impurities in water, Water analysis - Determination of different constituents in water – Hardness & Alkalinity, Numerical problems on hardness and alkalinity.Biochemical Oxygen Demand and Chemical Oxygen Demand.Numerical problems on BOD and COD.Sewage treatment. Potable water, purification of water - Flash evaporation, Electro dialysis and Reverse Osmosis. Hazardous chemicals with ill effects.Principles of Electronic, Atomic and emission spectroscopy.

Instrumental Methods of Analysis: 5 Hours

Theory, Instrumentation and Applications of Colorimetry, Potentiometry and Conductometry Principles and Instrumentation of Atomic Absorption Spectroscopy (AAS) and UV-Visible Double Beam Spectrometer with diagram.

Text Books

1. Dr. B.S. Jai Prakash, "Chemistry for Engineering Students", Subhas Stores, Bangalore, Revised Edition 2009

2. M. M. Uppal, "Engineering Chemistry", Khanna Publishers, Sixth Edition, 2001

3. Jain and Jain, "A text Book of Engineering Chemistry", S. Chand & Company Ltd. New Delhi, 2009

Reference Books

- Alkins P.W. "physical chemistry" ELBS IV edition 1998, London
- G. W. Gray and P. A. Winsor, "Liquid crystals and plastic crystals", Vol - I, Ellis Horwood series in Physical Chemistry, New York. (P. No. 106-142)
- M. G. Fontana, "Corrosion Engineering", Tata Mc Graw Hill Publications 1994.
- Stanley E. Manahan, "Environmental Chemistry", Lewis Publishers, 2000
- B. R. Puri, L. R. Sharma & M. S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Co., 33rd Ed.,1992
- Kuriakose J.C. and Rajaram J. " Chemistry in Engineering and Technology" Vol I & II, Tata Mc Graw – Hill Publications Co Ltd, NewDelhi, 1996.
- G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley - VCH.
- B. Viswanathan, S. Sivasanker , A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press.

Part II -CHEMISTRY LABORATORY

COURSE DESCRIPTION:

This course contains eleven experiments and aims at enabling the students to Practical Engineering Chemistry.

COURSE OBJECTIVES:

a) To understand the students with the working knowledge of chemical principles, nature and transformation of materials and their applications.
b) To develop analytical capabilities of students so that they can understand the role of chemistry in the field of Engineering and Environmental Sciences.

COURSE OUTCOMES:

Upon successful completion of the course, students will understand the

- Importance of chemistry for the preparation of materials for research activities.

- Instrumental methods of analysis like Conductometry, Colorimetry, Potentiometry and complexometry.
- Quantitative analysis of industrial importance.
- Transfer and measurement of chemicals.
- Solution preparation.
- Concentration of solution.
- Safety measures.

LEVEL OF KNOWLEDGE: Basic/working

PART-A

1. Determination of viscosity coefficient of a given liquid using Ostwald's viscometer.

2. Determination of copper by spectrophotometric method.

3. Conductometric estimation of an acid using standard NaOH solution

4. Determination of pKa value of a weak acid using pH meter.

5. Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution.

PART-B

1. Determination of Total Hardness of a sample of water using disodium salt of EDTA.

2. Determination of Calcium Oxide (CaO) in the given sample of cement by Rapid EDTA method.

3. Determination of Carbonate, Bicarbonate and Chloride contents in water.

4. Determination of Iron in the given sample of Haematite ore solution using potassium dichromate crystals by external indication method.

5. Determination of Chemical Oxygen Demand (COD) of the given industrial waste Water sample.

REFERENCE BOOKS:

1. J. Bassett, R.C. Denny, G.H. Jeffery, "Vogels text book of quantitative inorganic analysis",4th Edition

2. Sunita and Ratan Practical Engineering Chemistry, S.K. Kataria & Sons, 2010.

BASIC ELECTRONICS

Sub Code: EC133/EC233	L:T:P	Total Lecture Hrs :60
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

COURSE OBJECTIVES

- To impart basic knowledge about electronic and digital systems
- To give basic ideas about various communication systems

SYLLABUS

Unit – I :Basic Semiconductor and pn Junction Theory 9+3 Hours
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.

Unit – II :Diode Applications 9 + 3 Hours
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

Unit – III: Bipolar Junction Transistor 9+3 Hours
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.

Unit – IV: Introduction to Operational Amplifiers 9 + 3 Hours
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

UNIT – V: Digital Electronics 9 + 3 Hours
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.

COURSE LEARNING OUTCOMES

- Identify the applications and functions of electronics in Engineering.
- Recognise basic electronic components and devices used for different electronic functions.
- Be able to use basic techniques for analyzing analogue and digital electronic circuits.
- Be able to design analogue and digital electronic circuits at block level.

TEXT BOOKS

1. David A. Bell, "Electronic Devices and Circuits" – Vth Edition, OUP
2. N. P. Deshpande, "Electronic Devices and Circuits – Principles and Applications", TMH
3. Robert L Boylestad& Louis Nashelsky, "Electronic Devices and Circuit Theory", 3rd Edition.
4. Morris Mano, "Digital Logic and Computer Design", PHI, EEE

REFERENCE BOOKS

1. Donald A. Neamen, "Electronic Circuits", 3rd Edition, TMH
2. Thomas L. Floyd, "Electronic Devices", Seventh Edition, Pearson Education.
3. Albert Malvino, David. J. Bates, ―Electronic Principles‖, 7th Edition, Tata McGraw Hill, 2007

BASIC ELECTRONICS LABORATORY

Use basic source and measuring instruments (Power supply, function generator, CRO, DMM), Familiarization of breadboard.

1. Measurement of Voltage and Frequency using CRO. Study of step down transformer. Measuring the secondary voltage.
2. Identify and test electrical/electronic active and passive components
3. Color Coding of resistors and Capacitor Coding
4. Study of Series and Parallel circuits – Using Bread Board and DC power supply.
5. Half Wave Rectifier and Full Wave Rectifier
6. Study different types of logic gates
7. Solder and de-solder electronic components on different types of PCB
8. Assembling of RG-35 cable with BNC connectorization
9. Assembly and study of grid parabolic antenna
10. PCB design using software tool: a single sided (pattern side only) layout design of a simple circuit.

Basics of Computer Science and Engineering

Sub Code: CS134/CS234	L:T:P	Total Lecture Hrs :60
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

COURSE OBJECTIVES

To develop skill in problem solving concepts through learning C/C++ programming.

COURSE LEARNING OUTCOMES

- Students will be able to read, understand and trace the execution of programs written in C/C++ language.
- For a given algorithm students will be able to write the C/C++ code using a modular approach.
- Students will be able to design programs involving decision structures, loops, functions, and pointers.

SYLLABUS

UNIT – I: INTRODUCTION TO COMPUTERS 9 + 3 Hours

Introduction to Computers -Computer Systems, Basic organization of a computer, Computing Environments, Internet and World Wide Web, Information technology today, System software, Software engineering, Database management system, Computer network, Multimedia, IT in business, personal, social and ethical issues.

Problem formulation and problem solving, Computer Languages, Creating and running programs, Program Development.Introduction to the C/C++ Language –Background, example C/C++ programs, Preprocessor commands.

ALGORITHMS AND FLOWCHARTS

Algorithms, Flowcharts, Divide and conquer strategy. Examples on algorithms and flowcharts.

Constants, Variables, and Data types: Characters set, tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of variables.

UNIT – II: OPERATORS AND EXPRESSIONS: 9 + 3 Hours

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

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

Unit – III: ARRAYS 9 + 3 Hours
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, Scope, Storage classes -auto, register, static, extern, scope rules, type qualifiers, recursion –recursive functions, Limitations of recursion

Unit – IV: POINTERS 9 + 3 Hours
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, Functions Returning Pointers.

Unit – V: STRINGS, STRUCTURE, UNION, FILES 9 + 3 Hours
Strings: String concepts, C/C++ strings, String I/O functions, Array of strings, String manipulation function, Memory formatting, Derived types-Enumerated, Structure, and Union: The type definition, Enumerated types, Structure, Accessing structures, Complex structures, Array of structures, Structures and functions, Union , Files: Classification of Files, Standard Library Functions for Files.

TEXT BOOKS
1. Deitel and Deitel, "C How to Program", Prentice Hall 2010 (Reprint).
2. Herbert Schildt, "C++ : The Complete Reference", Mcgraw - Hill Osborne Media; 3rd edition 2012 (Reprint).
3. Yashvant Kanetkar, "Let Us C 13E", BPB Publications – 13th Edition, 2013.

REFERENCE BOOKS
1. Shelly and Junt, "Computers and Commemsense", 4th edition, Prentice Hall of India, 2010 (Reprint).
2. Deniis P. Curtin, KIMfolly, Kunal Sen, Cathleen Morin, "Information Technology", Tata MC GrawHill Companies, 2010 (Reprint).
3. Peter Norton, "Introduction to Computers", 2011 (Reprint).

COMPUTER PROGRAMMING LABORATORY

COURSE OBJECTIVES

- To impart the basic concepts of computer and information technology.
- To develop skill in problem solving concepts through learning C/C++ programming in practical approach.

COURSE LEARNING OUTCOMES

- Ability to analyze the problem and breading them into problem solving steps
- Ability to implement the a algorithm using procedural language constructs
- Ability to write a program for solving generic problems which could be solved using procedural based steps

SYLLABUS

1. To understand and realize the use of Constants, Variables, and Data types: Characters set, C/C++ tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of variables.
2. To understand and realize the use of 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 associativity.
3. To understand and implement concepts of 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.
4. To understand and implement concepts of the while statement, The do statement, The for statement, Jumps in Loops.
5. To understand and implement concepts of One-dimensional Arrays, Declaration of one-dimensional Arrays, Initialization of one-dimensional Arrays, Two-dimensional Arrays, Initializing two-dimensional Arrays.
6. To understand and implement concepts of A multi-function Program, Category of Functions, recursion –recursive functions.
7. 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, Functions Returning Pointers.
8. To understand and implement concepts of String , String I/O functions, Array of strings, String manipulation function.
9. To understand and implement concepts of Derived types-Enumerated, Structure, and Union.
10. To understand and implement File concepts in C/C++.

HARDWARE EXPERIMENTS:

- Assembling and de-assembling personal computers
- Types of Ports-Types of Connectors
- Overview of the preventive maintenance
- Operating system installations
- Basic networking concept

REFERENCE BOOKS

1. Deitel and Deitel, "C How to Program", Prentice Hall 2010 (Reprint).
2. Herbert Schildt, "C++ : The Complete Reference", Mcgraw - Hill Osborne Media; 3rd edition 2012 (Reprint).
3. Yashvant Kanetkar, “Let Us C 13E”, BPB Publications – 13th Edition, 2013.

ELEMENTS OF MECHANICAL ENGINEERING AND NANOSCIENCE

Sub Code: ME135/ME235	L:T:P	Total Lecture Hrs :60
Exam Marks: 100	Hrs/week : 3:1:0	Exam Hours : 03

COURSE OBJECTIVES

To familiarize with

- The Source of conventional and renewable energy recourses
- Fundamental concepts of thermodynamics and heat transfer
- Elementary concepts on prime movers like IC Engines and turbines
- Basic principles of refrigeration and air-conditioning.
- Concepts of power transmission system
- The various metal joining process.
- The Basic theory of machine tools.

COURSE LEARNING OUTCOMES

a) To be able to distinguish between different energy recourses
b) To demonstrate basic thermodynamic and heat transfer concepts
c) To distinguish between SI and CI engines and their working principles
d) To explain the working of turbines and their applications
e) To describe the functioning of refrigeration and air-conditioning
f) To be able to demonstrate work with machine tools and metal joining operations

UNIT-I ENERGY and its UTILISATION

Energy Resources **5 Hours**

Conventional Resources- Petroleum based solid, liquid and gaseous fuels. Combustion and atmospheric pollution due to combustion of fuels.Brief on Emission norms.

Non Conventional Resources: **5 Hours**

Solar Power, Solar Thermal energy harvesting, solar collectors, solar pond (principle of operation only), Solar photovoltaic principle. Wind Energy, Ocean Thermal, Geo- thermal, Tidal energy and bio mass energy- working principle. Brief on bio-fuels.

Merits and demerits of different energy resources.

UNIT-II THERMODYNAMICS and HEAT TRANSFER

Thermodynamics **6 Hours**

Basic concepts: State, path, process (reversible and irreversible), and cycle, System, surroundings and boundary. Closed system, Open system and Isolated Systems. I Law of Thermodynamics (conservation of energy). Concept of Internal energy and Enthalpy. Limitations of I Law and Introduction to II law (statements and brief description). Heat engine and Heat pump – Carnot cycle.Concept of entropy. (Simple problems on Carnot efficiency and COP)

Heat Transfer **6 Hours**

Applications of heat transfer. Modes of Heat transfer. Description of conduction, convection and radiation heat transfer-basic governing equations. Fins – types and applications. Heat exchangers-types. (only descriptions)

UNIT-III PRIME MOVERS

IC Engines 6Hours

Classification, I.C. Engines parts, 2 Stroke and 4 stroke operations. SI and CI engines, Problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, and specific fuel consumption.

A brief description of CRDI, MPFI, GDI and Hybrid Vehicles **2Hours**

Turbines 8 Hours

Steam Turbine:

Properties steam, boilers, fire and water tube boilers (Lancashire and Babcock and Will Cox boiler-working)

Classifications of steam turbines, Principle of operation of Impulse and reaction turbines, Delaval' s turbine, Parson' s turbine – working principles

Gas Turbine:

Working principles and operations of Open cycle and closed cycle gas turbines

Water turbines: Classification, Principles and operations of Pelton wheel, Francis turbine and Kaplan turbine

UNIT-IV Refrigeration and Air-Conditioning 5 Hours

Refrigeration-History and applications.Refrigerants and its properties.Refrigerating effect and unit of Refrigeration. Principle and working of vapor Compression refrigeration and vapour absorption refrigeration:

Air-conditioning 4 Hours

Psychometry - different temperatures and humidity. Components of an air conditioner.Principles and applications of air conditioners, Room air conditioner. Introduction on cryogenics

UNIT-V Machine Tools and Metal Joining 7 Hours

Lathe Machine, Types, Parts, and different operations like-turning, facing, knurling, tapering and thread cutting.

Drilling Machine- Drilling,, Boring, Counter Boring , and Reaming operation. Radial and vertical drilling machines (simple sketches)

Milling Machine – up milling, down milling, Plane milling, End milling, Slot milling and gear cutting (sketches only for operations)

Material Joining **6 Hours**

Soldering, Brazing and Welding : Definitions, classification and method of soldering, Brazing and welding. Differences between soldering, Brazing and Welding. Description of Electric, Arc Welding and Oxy-Acetylene Welding.

TEXT BOOKS

1. K.R. Gopalkrishna, "A text Book of Elements of Mechanical Engineering", Subhash Publishers, Bangalore.
2. S. Trymbaka Murthy, "A Text Book of Elements of Mechanical Engineering", 3rd revised edition,I .K. International Publishing House Pvt. Ltd., New Delhi. 2010.
3. Dr. R. P. Reddy, N. Kapilan, "Elements of Mechanical Engineering", 1st Edition, Himalaya Publishing House, New Delhi.

REFERRENCE BOOKS

1. SKH Chowdhary, AKH Chowdhary, Nirjhar Roy, "The Elements of Workshop Technology", Vol. I & II, Media Promotors and Publishers, Mumbai.
2. Ghosh Mallik, "Manufacturing Technology", TMH. HMT, Production Technology, TMH

ME 151 / ME 251 WORKSHOP PRACTICE

Sub Code: ME151/ME251	**L:T:P**	**Total Lecture Hrs :30**
Exam Marks: 100	**Hrs/week : 0:0:2**	**Exam Hours : 03**

PART-A

COURSE OBJECTIVES

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

SYLLABUS

1. Fitting

a) Study of fitting tools

b) Study of fitting operations & joints

c) 3- 5 models involving rectangular, triangular, semi circular and dovetail joints.

2. Welding

d) Study of electric arc welding tools & equipments

e) 2-3models - electric arc welding - Butt joint, Lap joint, T joint & L joint.

3. Sheet Metal

f) Study of development of surfaces

g) Minimum 01 models (Tray,Funnel,Cone)

4. Study and demonstration of Carpentry tools, joints and operations.

TEXT BOOKS

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

SEMESTER-II

MATHEMATICS II

(Common for all branches)

Sub Code: MA231	**L:T:P**	**Total Lecture Hrs :60**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

COURSE DESCRIPTION:

This paper contains five units which are Differential Calculus, Multiple integrals, Differential Equation of higher order and Laplace transformation and its Inverse with Vector integration. This paper aims at enabling the students to study the application of integration to various fields along with the different techniques to solve higher order linear differential equation.

COURSE OBJECTIVE:

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.

COURSE OUTCOMES:

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

UNIT – I: Differential Calculus – II **10 Hrs**

Polar curves and angle between Polar curves. Pedal equations of polar curves, Radius of curvature – Cartesian, parametric, polar and pedal forms.

UNIT –II:Integral Calculus – II **14 Hrs**

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

Beta and Gamma Function: Definition, Relation between Beta and Gamma Function, properties Application Problems.

UNIT –III:Differential Equations - II **12 Hrs**

Linear differential equations of second and higher order with constant coefficients.Method of undetermined coefficients.Method of variation of parameters.Legendre'a and Cauchy's homogeneous differential equations,phase plane, critical point, stability.

UNIT -IV:Laplace Transforms **14 Hrs**

Definition - Transforms of elementary functions. Derivatives and integrals of transforms-Problems.Periodic function.Unit step function and unit impulse function Inverse transforms – Properties.Convolution theorem, Solutions of linear differential equations.

UNIT -V:Vector Calculus - II **10 Hrs**

Vector Integration - Green's theorem in a plane, Gauss's divergence theorems, Stoke's, (without proof) and simple application.

TEXT BOOKS

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

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, Inc, 2005
2. Thomas and Finney, "Calculus", 9th Edition, Pearson Education, 2004
3. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Publication, Canada, 2007
4. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw – Hill, 2009.
5. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006.
6. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005.
7. Paras Ram, "Engineering Mathematics through Applications", 1st Edition, CBS Publisher, 2011.

Applied Physics

(Common for all branches)

Sub Code: PH132/PH232	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:2	Exam Hours : 03

COURSE DESCRIPTION

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 and Ultrasonics,

This paper aims at enabling the students to understand the fundamentals covered in this paper.

COURSE OBJECTIVES:

- To extend student's knowledge on the basic concepts and ideas in physics.
- To develop scientific attitudes and enable the students to apply the concepts of Physics with the core programmes.

COURSE OUTCOME :

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 and Ultrasonics in the field of Engineering.
- Apply optical phenomenon in technology.

UNIT – I **14 Hours**

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, The relation between group velocity and phase velocity, relation between phase velocity, particle velocity and velocity of light, Scanning electron microscope. Problems.

UNIT – II **12 Hours**

Quantum Mechanics

Heisenberg's uncertainty principle and its physical significance.Application of uncertainty principle (Non-existence of electron in the nucleus). Second order differential equation for a travelling wave. 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.

UNIT – III **12 Hours**

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 Temperature dependence of resistivity of metals.Band theory of solids - Merits of Quantum free electron theory.Problems.

UNIT – IV **12 Hours**

Materials Science and Ultrasonics

Elasticity : Introduction, types of moduli of elasticity - 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.

Ultrasonics : Ultrasonics production – Magnetostriction and Piezoelectric methods – Application (NDT) non-destructive testing of materials- Flaw detection- Measurement of velocity in liquids. Determination of elastic constants in liquids using Ultrasonic Interferometer.

Problems.

UNIT – V **10 Hours**

Applied Optics

Optics : Interference – thin films - Air wedge theory and experiment-Testing of flat surfaces. Anti reflection coating single and multi layer.Problems.

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.

TEXT BOOKS:

1. M.N.Avadhanulu and P.G. Kshirsagar, "A Text Book of Engineering Physics", S.Chand & Company Ltd, Revised Edition 2014.
2. John Wiley "Engineering Physics",Wiley India Pvt. Ltd, 1st Edition 2014.
3. S.O. Pillai, "Solid State Physics", New Age International, 7th Edition 2015.
4. S.P. Basavaraju, " Engineering Physics", Revised Edition 2015.
5. Charles *Kittel,* "Introduction to *Solid State Physics"* , 8th Edition.
6. Arthur Beiser, "Concepts of Modern Physics" , Special Indian Edition 2009.
7. Ajoy Ghatak, "Optics", 5th Edition 2012.

REFERENCE BOOKS:

1. R.K. Gaur and S.L. Gupta, "Engineering Physics", Dhanpatrai and Sons, New Delhi, 2011.
2. Sehgal Chopra Sehgal, " Modern Physics ", Tata McGraw-Hill, Revised Edition, 2014.
3. Halliday, Resnick and Krane, "Fundamentals of Physics Extended", John Wiley and Sons Inc., New York, 10th Edition, 2013.
4. P.Mani, "Engineering Physics", Dhanam publishers, Revised Edition 2011.
5. H.J. Sawant, "Engineering Physics", Technical Publications, Revised Edition, 2014.
6. V. Rajendran, "Engineering Physics", Tata Mcgraw Hill Publishing Company Limited, 1st Edition, 2009.
7. K.Eric Drexler, "Nanosystems - Molecular Machinery, Manufacturing and Computation", John Wiely & Sons, 2005.
8. J David, N Cheeke , "Fundamentals and Applications of Ultrasonic Waves", CRC Press 2nd Edition, 2012.
9. Frederick J Bueche and Eugene Hecht "Schaum Outline of Theory and Problems of College Physics", Tata McGraw-Hill, 11th Edition, 2012.
10. M. Ali Omar, " Elementary Solid State Physics", Addison-Wesley 1st Edition, 1993.

Physics Laboratory – PH 132 / PH 232 Syllabus 2017 – 2018

(Common for all branches)

SUBJECT DESCRIPTION:

This paper contains ten experiments and aims at enabling the students to Practical Engineering Physics.

SUBJECT OBJECTIVES:

- To develop scientific and experimental skills of the students
- To employ the theoretical principles with application based studies.

LEARNING OUTCOME:

- At the end of the course, the students will be familiarized with basic measuring instruments and will be able to relate the theoretical concepts through experiments.

LIST OF EXPERIMENTS

(Any Eight to be performed)

S NO.	Name of the experiment	Remarks
	Basic Measuring Instruments • Vernier Callipers • Screw Gauge • Travelling Microscope	General
1	Verification of Stefan's law	Unit -1
2	Planck's Constant (Determination of Planck's constant using LED or using the principle of photoelectric effect)	Unit -1
3	Thermal Conductivity of a bad conductor – Lee's disc apparatus	Unit -3
4	Determination of Fermi energy	Unit -3
5	Young's modulus – Non-uniform bending	Unit -4
6	Measurement of Dielectric Constant (Charging & discharging of capacitor)	Unit -4
7	Ultrasonic Interferometer	Unit -4
8	Interference at a wedge	Unit -5
9	Laser Diffraction (Determination of grating constant and number of rulings per inch using diffraction grating)	Unit -5
10	Frequency determination – Melde's apparatus	General Physics
11	Photo Multiplier Tube – Demonstration only	General Physics

Text Books:

1. Physics Laboratory Manual for the First / Second Semester B.Tech, CUFE, 2015.

Reference Book :

1. Sathyaseelan H, "Laboratory Manual in Applied Physics", New Age International, 3rd Edition, 2012.

BASICS OF ELECTRICAL ENGINEERING

Sub Code: EE133/EE233	L:T:P	Total Lecture Hrs :60
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

COURSE OBJECTIVES

By the end of the course students will be able

- *To identify and understand the electrical components.*
- *To solve the AC and DC electrical network*
- *To know the basic concepts of electrical power systems*
- *To explain the working principle, construction, applications of power system components.*
- *To understand the importance of renewable energy*
- *To apply electrical knowledge in day-to-day life.*

COURSE LEARNING OUTCOMES

By the end of the course students

- *Will be able to identify and analyze the different types of dc and ac circuits and determine the various electrical quantities related to it.*
- *Gain the thorough knowledge of power system components, generation, transmission and distribution system.*
- *Will be able to explain the different types of loads and tariff schemes.*
- *Describe the importance of Electrical Energy conservation and Effective usage of Electrical energy.*
- *Will be able to explain the principle of various generating plant both renewable and non-renewable.*

UNIT I BASIC ELECTRICAL CONCEPTS 9 + 3 Hours

Introduction to basic electrical quantities: Charge, Voltage, Current, Power and Energy. Active and passive elements – Basic Laws: Ohm's law - Kirchhoff's laws – Analysis of DC circuits– Direct method (only Branch current method) and Network Reduction method : Resistances in series, parallel, star and delta topology – Electromagnetism and its Applications - Faraday's Laws of electromagnetic induction - Lenz's law - Fleming's Right and Left Hand Rule.

UNIT II SINGLE PHASE AC CIRCUITS 9 + 3 Hours

Introduction to AC signal – Derivation of RMS, average, peak value of sinusoidal signal - Representation of AC signal - Relationship between voltage and current in circuits containing individual and combination of R, L and C- Impedance, Active, Reactive, Apparent power and Power Factor.

UNIT III BASICS OF ELECTRICAL POWER SYSTEM 9 + 3 Hours

General structure of electrical power system - power transmission & distribution voltage levels - Power system components: Alternator, Transformer, Transmission line, Fuse,

Miniature Circuit breaker (Construction and Working principle) – Introduction to three phase network, Comparison of Overhead and underground distribution System.

UNIT IV ELECTRICAL ENERGY UTILIZATION 9 + 3 Hours

Types of Loads and Tariff structure - Domestic wiring and its components: Incandescent lamp, fluorescent lamp, heater, protective devices and switches, Single phase Induction motors –Safety measures - Electrical engineering materials–conductor, insulator and semiconductor materials in electrical system - Electrical Energy conservation: Necessity and Measures.

UNIT V RENEWABLE AND NON-RENEWABLE ENERGY SOURCES 9 + 3 Hours

Sources of energy - Power generation: thermal, hydel, nuclear - Advantages of renewable energy sources - Power generation: solar, Electrical characteristics of PV cell, wind energy conversion, other renewable techniques. Introduction to smart grid-Basic architecture, Technologies; Introduction to Electric Vehicle and energy storage techniques.

TEXT BOOKS

1. Arthur Eugene Fitzgerald, David E. Higginbotham, Arvin Grabel, "Basic electrical engineering: circuits, electronics, machines, controls", McGraw-Hill, Fifth Edition. 2010
2. E. Hughes; "Electrical Technology",9th Edition", Pearson, 2008.

REFERENCE BOOKS

1. Dr. K Uma Rao and Dr. A Jayalakshmi, "Basic Electrical Engineering", Revised Edition, Sanguine Technical publishers, 2014.
2. Kothari D. P. & Nagarath I. J, "Basic Electrical Technology", TMH, Reprint 2011
3. Rajendra Prasad, "Fundamentals of Electrical Engineering", Prentice Hall of India Pvt. Ltd., 2014
4. K.A. Krishnamurthy and M.R Raghuveer, "Electrical, Electronics and Computer Engineering", 2nd Edition, T.M.H., 2011
5. D C Kulshreshtha, "Basic Electrical Engineering", TMH. 2011
6. Abhijit Chakrabarti, Sudipta Nath & Chandan Kumar Chanda, "Basic Electrical Engineering", TMH, 2010.

ELECTRICAL ENGINEERING EXPERIMENTS:

COURSE OBJECTIVESS

- To develop scientific and experimental skills of the students
- To correlate the theoretical principles with application based studies.

(60% of syllabus by Electrical Engineering and 40 % of syllabus by Civil Engineering)

SYLLABUS

List of Experiments

1. **Circuit Laws:**

   a. Verification of Kirchhoff's Voltage Law.
   b. Verification of Kirchhoff's Current Law.
2. **Wiring Practice and its cost estimation:**
   a. Multiple switching operation
   b. Two way switching operation
   c. AND/OR logic implementation
3. **Measurement of Electrical Energy:**
   a. Single Phase AC circuit with R Load
   b. Single Phase AC circuit with R L Load
4. **Measurement of phase angle difference (Power Factor) between supply voltage and supply current:**
   a. Single Phase R-L circuit
   b. Single Phase R-C circuit
5. Fault Detection and Rectification of home appliances such as Ceiling Fan, Table Fan, Electric Iron, and Electric Stove.
6. Determination of Electrical Characteristics of Photovoltaic Cells.
7. Demonstration of Assembling of Electrical Machines.

REFERENCE BOOKS

1. Electrical Workshop Laboratory Manual for the First / Second Semester B. Tech, CUFE, 2015.
2. Nagasarkar T. K. &Sukhija M. S., "*Basic Electrical Engineering*", OUP 2005
3. Kothari D. P. &Nagarath I. J, "*Basic Electrical Technology*", TMH 2004
4. Rajendra Prasad, "*Fundamentals of Electrical Engineering*", Prentice Hall of India Pvt. Ltd., 2005

BASICS OF CIVIL ENGINEERING AND ENGINEERING MECHANICS

Sub Code: CE134/CE234	**L:T:P**	**Total Lecture Hrs :45**
Exam Marks: 100	**Hrs/week : 3:1:2**	**Exam Hours : 03**

COURSE OBJECTIVES

1. The students will understand the basics of civil engineering and Engineering Mechanics
2. The students will understand the basic principles, laws, measurements, calculations and SI units.
3. 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.
4. The students will understand the basic concepts of forces in the member, centriod, moment of inertia & friction

COURSE LEARNING OUTCOMES

5. On completion of the course the student would able to:
6. Solve problems dealing with forces in a plane or space and equivalent force system in equilibrium. The student would be able to determine the support reactions for various types of structural supports of a determinate structure with point load, uniformly distributed load and uniformly varying loads. The student would also be able to determine centroids and moment of Inertia of regular and irregular bodies and solve problems involving bodies in frictional contact.

SYLLABUS

UNIT – I **5Hrs**

Scope of different fields of Civil Engineering: Structural Engineering, Geotechnical Engineering, Environmental Engineering, Water Resources Engineering, Transportation Engineering. Materials of construction - Stones, Bricks, Tiles, Timber, PCC, RCC, PSC and composite materials.

UNIT-II **10 Hrs**

Introduction to Engineering Mechanics: Rigid and deformable bodies, Definition of Force, classification of force systems, couples and their characteristics, Composition (resultant) and resolution (components) of forces, Resultant of coplanar concurrent and non concurrent force systems.

UNIT-III: **12 Hrs**

Equilibrium of force systems: Equilibrium of coplanar concurrent and non-concurrent system of forces, conditions of equilibrium, types of loads and supports, types of beams. Support Reactions of single span beams and trusses.

UNIT-IV: **9 Hrs**

Centroid and moment of inertia: Definition of centroid and centre of gravity, Centroid of simple plane figures, centroid of built up sections, definition of Moment of inertia / Second Moment of area, radius of gyration, Parallel axis theorem and Perpendicular axis theorem, MI of compound areas, Polar MI and radius of gyration.

UNIT-V: 9 Hrs

Friction: Introduction, Laws of static friction, limiting friction, angle of friction, angle of repose, block friction on horizontal and inclined planes, ladder and wedge friction.

TEXT BOOKS

1. Bhavikatti S.S. "Elements of Civil Engineering (IV Edition) and Engineering Mechanics",2/E, Vikas Publishing House Pvt. Ltd., New Delhi, 2008
2. Jagadeesh T.R. and Jay Ram, "Elements of Civil Engineering and Engineering Mechanics", 2/E, Sapana Book House, Bangalore, 2008.
3. Shesh Prakash and Mogaveer, "Elements of Civil Engineering and Engineering Mechanics", 1/E, PHI learning Private Limited, New Delhi, 2009.

REFERENCE BOOKS

1. Bansal R. K, "Engineering Mechanics", LaxmiPublications(P) Ltd, New Delhi, 1995
2. Ferdinand P. Beer and E. Russel Johnston Jr., "Mechanics for Engineers: Statics",8/E, McGraw-Hill Book Company, New Delhi. 2007
3. Goyal and Raghuvanshi., "Engineering Mechanics", New Edition, PHI learning Private Limited, New Delhi.
4. Irvingh H Shames, "Engineering Mechanics", 4/E, PHI learning Private Limited, New Delhi, 2008
5. Jivankhachane&Ruchishrivasatava, "Engineering Mechanics", Ane's Student Edition, Anne Book India, New Delhi, 2006.
6. Kolhapure B.K., "Elements of Civil Engineering & Engineering Mechanics", 1/E, EBPB Publications, Belgaum, 2003.
7. Lakshmana Rao, et al., "Engineering Mechanics - Statics and Dynamics", New Edition, PHI learning Private Limited, 2009.
8. Meriam J. L, and Kraige., L. G , "Engineering Mechanics", 5/E, Volume I, Wiley India Edition, India, 2009.
9. Nelson, "Engineering Mechanics", New Edition, Tata McGraw-Hill Education Pvt. Ltd, 2009
10. Palanichamy M.S., "Engineering Mechanics (Statics & Dynamic)", 3/E, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2008.
11. Sawant H. J, &Nitsure.,"Elements of Civil Engineering (IV Edition) and Engineering Mechanics", New Edition, Technical publications, Pune, India, 2010.
12. Sawhney, "Engineering Mechanics", New Edition, PHI learning Private Limited, New Delhi, 2008. Timoshenko and Yong, "Engineering Mechanics", 5/E, Tata McGraw-Hill Book Company, New Delhi, 2007.

CIVIL ENGINEERING EXPERIMENTS

COURSE LEARNING OUTCOMES

At the end of this course, students should be able

- To demonstrate the relationship between voltage and current in resistive as well as inductive circuit.

- To demonstrate various wiring topologies of house hold applications such as stair-case wiring, three wire control etc.
- To familiarize the significance of power factor in an AC circuit and its improvement.
- To understand working of a single phase transformer and various losses associated with the same.
- To measure energy using an energy meter.

1.Test on Building Bricks: Compressive strength and Water Absorption test on Bricks with reference to IS: 3495(Part-1 and 2)-1992

2. Test on Flooring and Roofing Tiles: Abrasion value test on flooring tile and Water

absorption test on roofing tiles with reference to IS 1237 : 2012 and IS 654-1992

3. Tests on Fine aggregates: Water absorption/Moisture content, Specific gravity and Sieve analysis with reference to IS: 383-1970

4. Tests on Coarse aggregates: Water absorption/Moisture content, Specific gravity and Sieve analysis with reference to IS: 383-1970

5. To measure the distance between two points using direct ranging.

6. To set out perpendiculars at various points on given line using cross staff, optical square and tape

7. Setting out of rectangle, hexagon using tape/chain and other accessories.

REFERENCE BOOKS

1. Kukreja C.B., Kishore K.Ravi Chawla., "Material Testing Laboratory Manual", Standard Publishers & Distributors 1996
2. Gambhir M.L., "Concrete Manual", Dhanpat Rai & Sons, New Delhi.
3. Duggal S.K., "Surveying", Vol-I", Tata McGraw Hill - Publishing Co. Ltd. New Delhi.
4. Punmia. B.C., "Surveying Vol–1",Laxmi Publications, New Delhi

ENGINEERING GRAPHICS

Sub Code: ME135/ME235	L:T:P	Total Lecture Hrs :84
Exam Marks: 100	Hrs/week : 2:2:0	Exam Hours : 03

COURSE OBJECTIVES

- To draw and interpret various projections of 1D, 2D and 3D objects..
- To prepare and interpret the drawings.
- Hands on training in Solid Edge.

COURSE LEARNING OUTCOMES

- Will be in a position to convert vision /imagination into reality.
- Acquires knowledge of scaling.
- Can develop plan and elevation of geometrical objects.
- Can produce development of surfaces.
- Draw isomertic projection of objects.

SYLLABUS

UNIT - I Introduction to Computer Aided Sketching 6 Hrs

Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practicing. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes.Definitions of HP, VP, RPP & LPP.Creation of 2D/3D environment.Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. Dimensioning, line conventions, material conventions and lettering

UNIT – II Orthogonal Projections 15 Hrs

Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only), True and apparent lengths, True and apparent inclinations to reference planes (No application problems).

UNIT – III Orthographic Projections of Plane Surfaces (First Angle Projection Only) 15 Hrs

Introduction, Definitions – projections of plane surfaces – triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method only (No problems on punched plates and composite plates)

UNIT – IV PROJECTIONS OF SOLIDS 18 Hrs

Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions. (No problems on octahedrons and combination solid).

UNIT – V Sections And Development of Lateral Surfaces of Solids 15 Hrs

Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. (No problems on sections of solids) Development of lateral surfaces of above solids, their frustums and truncations. (No problems on lateral surfaces of trays, tetrahedrons, spheres and transition pieces).

UNIT – VI Isometric Projection (Using Isometric Scale Only) 15 Hrs

Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres and combination of solids (Maximum of three solids).

TEXT BOOKS

1. K.R. Gopalakrishna, "Engineering Graphics", 15th Edition, Subash Publishers Bangalore.

2. Basant Agrawal, C. M. Agrawal, "Engineering Drawing", TMH.

3. N.D. Bhatt, "Engineering Graphics, Elementary Engineering Drawing", 48th Edition, Charotar Publishing House, 2005.

4. S. Trymbaka Murthy, "Computer Aided Engineering Drawing", I.K. International Publishing House Pvt. Ltd., New Delhi.

5. P. J. Shah, "A Text Book og Engineering Graphics", S. Chand & Company Ltd., New Delhi

6. Arunoday Kumar, "Engineering Graphics – I and II", Tech – Max Publication, Pune.

7. T. Jeyapoovan, "Engineering Drawing & Graphics using Auro CAD 2000", Vikas Publishing Hoise Pvt. Ltd. , New Delhi.

8. R. K. Dhawan, "A Text Book of Engineering Drawing", by S. Chand & Company Ltd., New Delhi.

9. P. S. Gill, "A Text Book of Engineering Drawing", S K Kataria & sons, Delhi.

10. D. A. Jolhe, "Engineering Drawing with an Introduction to Auto CAD", D. A. Jolhe Tata McGraw – Hill Publishing Co. Ltd., New Delhi.
11. S. Trymbaka Murthy, "Computer Aided Engineering Drawing", I.K. International Publishing House Pvt. Ltd., New Delhi.

PROFESSIONAL DEVELOPMENT- I

Sub Code: PD136/236	L:T:P	Total Lecture Hrs :60
Exam Marks: 100	Hrs/week : 3:1:0	Exam Hours : 03

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. Able to make an organized and complete oral presentation to meet the needs of individuals and small groups.

COURSE LEARNING OUTCOMEs

- Ability to communicate and interact
- Ability to write essays and improve the articulation of writing

SYLLABUS

Unit-I Business Communication 12 Hrs

Introduction: Role of communication – defining and classifying communication – purpose of communication – process of communication – characteristics of successful communication – Barriers of Communication- Importance of communication in management – communication structure in organization :Formal and informal communication– Communication in crisis.

HR interaction on Business communication

Oral communication: Principles of successful oral communication – barriers to communication –conversation control – reflection and empathy: two sides of effective oral communication – effective listening – non – verbal communication.

Unit-II Soft Skills and Employment Communication 12 Hrs

Personality development, Emotional intelligence, Lateral thinking, Leadership skills, Assertiveness, Teams man ship , Time management, Presentation skills, Group discussions and personal interviews. Business etiquette. , Body Language, Understanding Personal Space, Cross Cultural Communication, Conflict Resolution, Stress Management, Appropriate humour at workplace. **HR interaction on presentation skills**

Unit - III Functional English Grammar 12 Hrs

Parts of Speech, Phrases &Clauses ,Tenses, Concord ,Passive and Active Voice, Run on, fragments, Parallel Structure, Vocabulary – Commonly confused and misused words. Idioms, Misplaced & Dangling Modifiers.

Unit- IV Reading and Case method of learning 12 Hrs

Regular & Extended paragraphs, Types of paragraphs, Topic sentence, supporting evidence. Analysis of regular & extended Paragraphs. Different types of paragraphs.**HR interaction on case study.** Understanding the case method of learning – different types of cases – analyzing a case .(Previewing, skimming, reading, scanning). – Do's and don'ts for case preparation. Purpose of writing – clarity in writing –Principles of effective writing.Pre writing – Writing – Revising – Editing. Specific writing features – Unity & coherence in writing.
Business letters: Introduction to business letters – writing routine and persuasive letters – positive and negative messages- writing memos – what is a report, types of reports- purpose and objectives of reports.

Unit- VAcademic Writing 12 Hrs
Patterns of Essay development-Analysis of academic essays- Pre writing techniques.Thesis statement and supporting details.Purpose of writing – clarity in writing –Principles of effective writing - unity , coherence, support &sentence skill in writing. Essay outline.Different types of Academic Essays.Narratives, descriptive, classification, comparison and contrast.Argumentative and process essays.

TEXT BOOK

1. Business communication: Concepts , cases and applications – P D Chaturvedi, mukesh Chaturvedi Pearson Education 1/e,2004 (module1,2,4,5,&7)

REFERENCE BOOKS

1. College Writing Skills with Readings: John Langan.
2. Business Communication, process and Product – Mary Ellen Guffey – Thomson Learning, 3/E, 2002 (Module 3)
3. Basic Business Communication – Lesikar , Flatley TMH10/E, 2005 (Module 1,2,4,5,&7)
4. Business Communication, M K Sehgal & V Khetrapal, Excel Books.
5. Effective Technical Communication By M Ashraf Rizvi – TMH 2005
6. Business Communication Today by Bovee Thill Scatzman – Pearson & Education , 7th Ed,2003
7. Contemporary Business Communication – Scot Ober-Bitztanntra,5/e
8. Business Communication – Krizan , Merrier, Jones- Thomson Learning , 6/e, 2005
9. Business Communication – Meenakshi Raman. Prakash Singh.

SEMESTER III

MATHEMATICS III

Sub Code: MA331	**L:T:P**	**Total Lecture Hrs :49**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

COURSE Description:

This paper contains five units which are Fourier Series, Fourier Transform, Partial Differential Equation, Numerical Analysis and Calculus of Variation. This paper enables the students a solid foundation upon the fundamental theorems and application of different transformations. It also help the students to have an in depth knowledge of various advanced numerical methods and interpolation techniques. Different methods to solve a partial differential equation and calculus of variation are also covered in this paper.

COURSE objective:

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.

COURSE OUTCOMES:

Students would be able to

- Expand the function as a Fourier series and harmonic analysis of the given data.
- Find Fourier transforms of non-periodic functions.
- Form the partial differential equations and solve it by methods of variable separable, Fourier series, D'Alembert's.
- Solve the algebraic and transcendental equations by Newton - Raphson and Regula - Falsi methods.
- Interpolate and Extrapolate the data of equal and unequal intervals by applying finite differences, Divided differences, Lagrange's interpolation and inverse interpolation formulae.
- Find the optimal values of the functional by applying Euler's equation.

UNIT – I: Fourier Series **12 Hours**

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.

UNIT – II: Fourier Transform **12 Hours**

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.

UNIT-III: Partial Differential Equations **14 Hours**

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)

UNIT-IV: Numerical Methods – I **10 Hours**

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.

UNIT-V: Calculus of Variations **12 Hours**
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.

TEXT BOOK:

1. Dr. B. Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, July 2014.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons,Inc. 2011.
2. B.V. Ramana, 6th Reprint, "Higher Engineering Mathematics", Tata-Macgraw Hill, 2008
3. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006.
4. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005
5. H. K. Das & Rajnish Verma, "Higher Engineering Mathematics", 20th Edition, S. Chand & Company Ltd., 2012

MATERIAL SCIENCE AND METALLURGY

Sub Code: ME332	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Provides basic knowledge about engineering materials and metallurgy.

Course Objectives:

- To comprehend the different properties, structures and imperfections present in materials.
- Interpret the nuances of failure in materials through fatigue, fracture and creep.
- To identify the physical and chemical properties of a material by having thorough knowledge in breaking down the phase diagrams to its elements and studying it.
- To analyze the need of novel materials and put forth the learnings in the form of applications relevant to the society.

Level of knowledge: Basic.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Identify the microstructure and distinctly bring out the properties of the materials.

CO2: Determine the phase diagrams and compositions for different class of metals and alloys.

CO3: Identify the heat treatment process for a material in an industry.

CO4: Define the fatigue, fracture and creep factors in a material.

CO5: Distinguish between the ferrous and non ferrous materials.

UNIT–I **10hours**

CRYSTAL STRUCTURE:BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections -point line and surface imperfections, introduction to SEM and TEM. Atomic Diffusion: Phenomenon, Flick's laws of diffusion, factors affecting diffusion, plastic deformation of single crystal by slip and twinning, atomic bonding and characterization of metals, ceramics and polymers, definition of lattice points and common lattice structures in materials.

NANOMATERIALS: Introduction, Synthesis, Properties, Introduction to Nanotubes.

UNIT – II **09 hours**

SOLIDIFICATION: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures.

PHASE DIAGRAM I: Solid solutions Hume Rothary rule substitution, and interstitial solid solutions, intermediate phases, Gibbs phase rule.

UNIT – III **10 hours**

PHASE DIAGRAM II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Iron carbon equilibrium diagram

HEAT TREATING OF METALS: TTT curves, annealing and its types, Normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminum-copper alloys.

UNIT – IV **10 hours**

FRACTURE: Type I, Type II and Type III.

CREEP: Description of the phenomenon with examples, three stages of creep, creep properties.

FATIGUE: Mechanism of fatigue, fatigue properties, fatigue testing and SN diagram.

UNIT -V **9 hours**

FERROUS, NON-FERROUS AND COMPOSITE MATERIALS: Classification of ferrous and nonferrous materials, composition and uses of cast iron, types and classification of composites.

CORROSION: Introduction, forms of corrosion, corrosion, prevention, electrochemical consideration, corrosion environments.

SMART MATERIALS: Introduction, Evolution, Classification, Applications, Introduction to Shape Memory Alloys

TEXT BOOKS

1. Foundations of Materials Science and Engineering, Smith, 3rd Edition McGraw Hill, 2009.
2. Shackleford, & M. K. Muralidhara ,"Materials Science",Pearson Publication – 2007.
3. Functional Materials, Electrical, Dielectric, Electromagnetic, Optical and Magnetic Applications, DDL Chung, World Scientific – Volume 2, March 2010.

REFERENCE BOOKS

1. Alan Cottrell, "An Introduction to Metallurgy", 2nd Edition, University Press India Pvt Ltd, 2000.

2. W.C.Richards ,"Engineering Materials Science", PHI, 1965

3. Y.Lakhtin," Engineering Physical Metallurgy",New Delhi CBS Publishers and Distributors 1998.

4. V.Raghavan, "Materials Science and Engineering", 6th edition, Prentice Hall India, 2015.

5. H. VanVlack, Addison "Elements of Materials Science and Engineering", Wesley Edn., 1998

6. William D Callister ,"Material Science and Engineering", 2nd Edition, John Wiley and Sons, 2014.

7. Askeland, Donald R; Fulay, Pradeep P; Wright, Wendelin J; Balani, Kantesh,"The Science and Engineering of Materials", 6th Edition, Cengage Learning Publishers, 2012.

BASIC THERMODYNAMICS

Sub Code: MA333	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course provides the basic knowledge about Thermodynamic laws and relations, their application to various processes. A thorough discussion on energy conversion processes involving heat and work are explained elaborately with the help of Laws of thermodynamics. The concept of entropy and availability are also included to understand the possibility of a process in a certain direction.

Course Objectives:

- Expose the fundamentals of thermodynamics via real world engineering examples
- Understand the nature and role of the following thermodynamic properties of matter: internal energy, enthalpy, entropy, temperature, pressure and specific volume
- Represent various thermodynamic processes on appropriate thermodynamic diagrams, such as a temperature-entropy or pressure-volume diagram
- Represent a thermodynamic system by a control mass or control volume, distinguish the system from its surroundings, and identify work and/or heat interactions between the system and surroundings;
- Recognize and understand the different forms of energy and restrictions imposed by the first law of thermodynamics on conversion from one form to another
- Be able to apply the first law to a control mass or control volume at an instant of time or over a time interval

Level of Learning: Basic.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Express the basic concepts of thermodynamics and zeroth law of thermodynamics on thermal systems to device a thermometer

CO2: Develop relation between heat and work for a given thermal system using first principle

CO3: To solve thermal systems using Fist law of thermodynamics and second law of thermodynamics

CO4: Estimate entropy for a given system using the concepts of available and unavailable energy

CO5: Distinguish between ideal and real gases using first principle

UNIT – I **10 Hours**

FUNDAMENTAL CONCEPTS & ZEROTH LAW: Revision of definition and scope. Microscopic and Macroscopic approaches. System (closed system) and Control Volume (open system);, Thermodynamic properties;, intensive and extensive properties. Definitions of state, path, process and cycle. Quasi-static process

THERMODYNAMIC EQUILIBRIUM; **ZEROTH LAW OF THERMODYNAMICS**, Temperature; concepts, scales, measurement. Internal fixed points.

UNIT – II **10 Hours**

WORK, HEAT AND FIRST LAW OF THERMODYNAMICS FOR NON-FLOW SYSTEMS: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention.PMM-I.Displacement work; expressions for displacement work in various processes through p-v diagrams.

FIRST LAW OF THERMODYNAMICS: Joule's experiments, equivalence of heat and work,.Extension of the First law to non –cyclic processes, energy, energy as a property. Applications of first law for various thermodynamics processes

UNIT – III **9 Hours**

FIRST LAW OF THERMODYNAMICS: for flow systems, enthalpy, Specific heat Extension of the First law to control volume; steady state steady flow energy equation, important applications, Application of SFEE for different flow systems.

SECOND LAW OF THERMODYNAMICS: Devices Thermal reservoir. Direct heat engine; reserved heat engine, heat pump and refrigerator. Kelvin –Planck and Clasius's statement .of Second law of Thermodynamic; equivalence of the two statements; PMM II.

UNIT – IV **10 Hours**

ENTROPY: Reversible and irreversible processes, Factors that make a process irreversible. Carnot cycle and principles.Thermodynamic temperature scale. Clasius's inequality. Entropy; a property, principle of increase of entropy, Calculation of entropy using T.ds relations.

AVAILABLE AND UNAVAILABLE ENERGY: Maximum Work, maximum useful work for a system and a control volume, availability of a system and a steadily flowing stream, irreversibility. Second law efficiency.

UNIT – V **9 Hours**

IDEAL GASES: Ideal Gas definition Gas Laws: Boyle's law, Charle's law, Avagadro's Law, Equation of State, Ideal Gas, Universal Gas constant, Evaluation of heat transfer, work done, internal energy. change in entropy, enthalpy for various quasi-static processes.

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.

TEXT BOOKS:

1. P.K.Nag, "Basic and applied Thermodynamics",2Edition, Tata Mcgraw-Hill Publishing Company 2009.

2. Cengel, Yunus A; Boles, Michael A, "Thermodynamics : An Engineering Approach", 8Edition, Tata McGraHill, 2016

REFERENCE BOOKS

1. R.K.Rajput,"A Textbook of Engineering Thermodynamics", 4th Edition, Laxmi Publications Pvt Ltd, 2016.

2. J.B. Jones and G.A.Hawkins,"Engineering Thermodynamics ", 2nd Edition, John Wiley & Sons, 7 May 1986

3. S.C. Gupta,"Thermodynamics", Pearson Education Pvt Ltd, 2015

STRENGTH OF MATERIALS

Sub Code: ME334	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

Course Description: provides basic knowledge about forces acting on bodies.

Course Objective:

- To determine the behavior of the element when it is subjected to stresses and strains
- To study various methods of calculating stresses and strains.
- To study the behavior under axial and transverse loading.
- Study the principle stresses, Biaxial and triaxial state of stresses.

Level of Knowledge: Basic.

Course Outcomes:

Upon completion of this course, the students will be able to

Upon completion of this course, the students will be able to
CO1: Understanding the concepts of Stress, strain and relationship between them to solve the problems of one dimensional, two dimensional and three dimensional elastic body.
CO2: Representing stress diagrams in simple structures and bars.
CO3: Understanding basics of solving problem related uniform and non-uniform bending for simple and complex structure/body.
CO4: Solve problems relating to torsional deformation of bars and other simple tri-dimensional structures.

UNIT-I **10 Hours**

SIMPLE STRESS AND STRAIN: Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation - behavior in tension for Mild steel, cast iron and non ferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self weight, Principle of super position.

Stress in Composite Section: Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars).

UNIT-II **10 Hours**

COMPOUND STRESSES: Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.

ENERGY METHODS: Work and strain energy, Strain energy in bar/beams, castiglinios theorem, Energy methods.

THICK AND THIN CYLINDER Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume). Thick cylinders Lame's equation (compound cylinders not included).

UNIT-III **10 Hours**

BENDING MOMENT AND SHEAR FORCE IN BEAMS: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.

UNIT-IV **10 Hours**

BENDING AND SHEAR STRESSES IN BEAMS: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress,radius of curvature, relationship between bending moment and radius of curvature.Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (Composite / fletched beams not included).

UNIT-V **10 Hours**

DEFLECTION OF BEAMS: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment.Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method

TORSION OF CIRCULAR SHAFTS AND ELASTIC STABILITY OF COLUMNS: Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts

COLUMNS: Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula.

LAB COMPONENT: **30 Hours**

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.
2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.
3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
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

PART – B

1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
4. Izod and Charpy Tests on M.S,C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

TEXT BOOKS

1. R.C.hibbeler, "Mechanics of materials", 9Edition,Printice hall. pearson edu., 2014.
2. James.m.gere;Stephe Timoshenko, "Mechanics of materials",2nd Edition CBS Publishers, 2016.
3. Ferdinand P Beer; E. Russel Johnson;John T Dewolf;David F Mazurek; Sanjeev. Sanghi,"Mechanics of materials", Tata mcgrawhill- 2013.

REFERENCE BOOKS

1. S.S. Rattan, "Strength of Materials",3 Edition, Tata McGraw Hill, 2011.
2. S.S.Bhavikatti, "Strength of Materials",4Edition,Vikas publications House Pvt. Ltd., 2013.
3. K.V. Rao, G.C. Raju, "Mechanics of Materials", First Edition, 2007
4. Egor.P. Popov,"Engineering Mechanics of Solids", Pearson Edu. India, 2008.
5. W.A. Nash, Schaum's Outlines Strength of Materials,Tata Mcgraw-Hill Publishing Company 2010.
6. R.K. Rajput"Strength of Materials",S.Chand& co Ltd. New Delhi, 2015
7. R.KBansal, "Strength of Materials",Lakshmi Publication (P) Ltd, New Delhi,2009.

NON CONVENTIONAL ENERGY RESOURCES

Sub Code: ME335	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

Course Description: The course discusses the use of solar (thermal and photovoltaic), hydro-electric, wind, geothermal, ocean thermal, wave, tidal and geothermal energy, as well as energy from biomass. The use of fuel-cell systems is dealt with. Issues relevant to energy efficiency and energy storage are discussed. The potential of using renewable energy technologies as a replacement for conventional technologies are discussed. Strategies for enhancing the future use of renewable energy resources are presented

Course Objectives:

The purpose of this course is to impart the importance of the most important renewable energy resources, and the technologies for harnessing these energies

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: To classify and compare the various solar thermal systems like: Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers and solar photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes

CO2: To examine the working of wind, Tidal and wave energy with respect to their types, advantages and disadvantages.

CO3: To describe the concept of thermoelectric system and classify the various biomass and biofuels for Thermo-chemical conversion, direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion and anaerobic digestion.

CO4: To classify and apply the concept of vapour dominated and liquid dominated system in geothermal energy. To describe the MHD open and closed systems.

CO5: To classify and compare the acidic and alkaline hydrogen-oxygen fuel cells, and to explain the Hydrogen production, storage and utilization.

UNIT 1 **10 Hours**

SOLAR ENERGY: Global and National scenarios, Form and characteristics of renewable energy sources, Solar radiation, its measurements and prediction, Solar thermal collectors,

flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems

SOLAR PHOTOVOLTAIC: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes

UNIT 2 **09 Hours**

WIND ENERGY: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristic, applications

TIDAL AND WAVE ENERGY: Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy

UNIT 3 **09 Hours**

THERMOELECTRIC SYSTEMS: Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators

BIOMASS AND BIOFUELS: Biomass resources and their classification, Biomass conversion processes, Thermo-chemical conversion, direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, types of biogas Plants, applications, alcohol production from biomass, bio diesel production, Urban waste to energy conversion-Biomass energy program in India

UNIT 4 **09 Hours**

GEOTHERMAL ENERGY: Introduction, classification of geothermal systems vapour dominated, liquid dominated system, total flow concept, petrothermal systems, magma resources, applications of geothermal operational & environmental problems

MAGNETO HYDRO DYNAMIC POWER GENERATION: Introduction principles of MHD power generation, MHD open and closed systems, power output from MHD generators, design problems of MHD generation, gas conductivity, seeding

UNIT 5 **10 Hours**

ELECTROCHEMICAL EFFECTS AND FUEL CELLS: Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells

HYDROGEN ENERGY: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

LAB COMPONENT: **30 Hours**

PART - A

1. Determination of Overall Heat Loss Co-efficient, Heat Removal Factor and Efficiency for Flat plate collector for FLATE PLATE COLLECTOR with thermosyphonic mode of flow.
2. Determination of Overall Heat Loss Co-efficient, Heat Removal Factor and Efficiency for Flat plate collector for FLATE PLATE COLLECTOR with forced mode of flow.
3. To determine the Performance Overall Heat Loss Co-efficient, Heat Removal Factor and Efficiency of the Parabolic Trough collector with fixed parameters with water and oil as working fluid.
4. To determine the Performance Overall Heat Loss Co-efficient, Heat Removal Factor and Efficiency of the Parabolic Trough collector with varying Solar Radiation with water and oil as working fluid
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.

PART - B

1. Evaluation of cut-in speed of wind turbine
2. Evaluation of Tip Speed Ratio (TSR) at different wind speeds
3. Evaluation of Coefficient of performance of wind turbine
4. Characteristics of turbine (power variation) with wind speed
5. Characteristics of fuel cell with the help of resistive load or DC-DC converter
6. Output power variation of fuel cell with change in Hydrogen supply

TEXT BOOKS

1. Rai.G.D, "Non-Conventional Energy Sources", 4 th edition, Khanna Publishers, New Delhi, 2011

2. Domkundwar.V.M, Domkundwar.A.V, "Solar energy and Non-conventional sources of energy", 1st edition, Dhanpat rai & Co. (P) Ltd, New Delhi, 2010

REFERENCE BOOKS

1. S P Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", 2ND EDITION , Tata McGraw Hill, 15TH REPRINT 2006

2. J.A.Duffie and W.A.Beckman, "Solar Engineering of Thermal processes", 4TH edition, John Wiley, New York, April 2013

3. Bockris and Srinivasan, "Fuel Cells", Springer; Softcover reprint of hardcover 1st ed. 2006 edition

4. Godfrey Boyle, "Renewable energy", 2nd edition, Oxford University Press, 2010

5. Khan.B, "Non-conventional Sources of energy", 2nd edition, New Delhi, Tata

McGraw Hill, 2009

6. Tiwari.G.N, Ghosal.M.K, "Fundamentals of renewable energy sources",1 st edition,

UK, Alpha Science International Ltd, 2007

7. Twidell.J.W and Weir.A.D, "Renewable Energy Resources",2nd edition, UK, E.&F.N.Spon Ltd, 2015

PROFESSIONAL DEVELOPMENT-II

Sub Code: PD336	L:T:P	Total Lecture Hrs :58
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: The subject makes an attempt to incorporate all basic concepts and practices of management, Business functions and economics that provides the foundation framework to guide the formative knowledge of Management Concepts and also the Concepts of Economic Systems, Economic behaviour of individuals and organizations

Course Objectives: At the end of the course the students would be capable of relating the principles of management and economics with the Environment of Business & economics, personal experiences and cases which will be attempted in the class.

Learning Outcomes:

Students would have the basic managerial skills to be the team leader of a group of employees in their workplace and some basic ideas about the entrepreneurial skills, if they are looking towards a start up of their own.

UNIT 1 **8 Hours**

PRINCIPLES OF MANAGEMENT

Management: Introduction: Definition of management, nature, purpose and functions, level and types of managers, Manager/Non-Manager, Managerial Roles, Essential Managerial Skills, Key personal characteristics for Managerial success.

Evolution and various schools to management thoughts, continuing management themes – quality and performance excellence, global awareness, learning organization, Characteristics of 21st century Executives. Social responsibility of managers.

UNIT 2 **16 Hours**

Planning: Meaning and nature of planning, types of plans, steps in planning process;Objectives: meaning, setting and managing objectives – MBO method: concept and process of managing by objectives;

Strategies: definition, levels of strategies, its importance in an Organization; Policies: meaning, formulation of policies; Programs: meaning, nature; Planning premises: concept, developing effective planning premises;

Decision making, steps in decision making, approaches to decision making, types of decisions and various techniques used for decision making.

Organizing: Organizing as managerial function – organization structure, formal and informal organization. Traditional Organization Structures – Functional, Divisional and Matrix Structure

Directions in organizational Structures – Team structure, network structure, boundary less structure

Organizing Trends and Practices – Chain of command, unity of command, span of control, delegation and empowerment, decentralization and use of staff, organizational design and organizational configuration.

UNIT 3 **14 Hours**

Leading as a function of management, Leadership and vision, Leadership traits, classic Leadership styles.

Leaders behaviour – Likert's four systems, Managerial Grid. Overlapping role of leader and managers. The organizational context of communication, Directions of communications, channels of communication, Barriers to communication. Motivation and rewards, rewards and performance.Hierarchy of need theory and two factor theory.Integrated model of motivation.

Controlling: Control function in management, The basic control process. Types of control – feed forward, concurrent and feedback controls.Factors in control effectiveness.

UNIT 4 **6 Hours**

FINANCE – Introduction to Financial Management and scope of Financial Management, Sources of funds.

MARKETING – Introduction to Marketing management, Marketing Mix- 4P's and Services Marketing.

HRM- Introduction , Organisation Structure, Types of Resource Selection.

OPERATIONS MANAGEMENT – Introduction to Operations Management , Project Management – CPM & PERT.

UNIT 5 **14 Hours**

ENTREPRENEURSHIP

Introduction- Definition, Nature and importance of Entrepreneurs, Role of entrepreneurship in economic development, Challenges faced by entrepreneurs - individuals - from family - from groups - from community - from society,

Entrepreneurial process: Identify and evaluate opportunities, Develop a Business plan, Determine the resources required, Manage the Enterprise,

Ethics and Social responsibility of Entrepreneurship.Intrapreneurship, Establishment of Intrapreneurship in organizations,

The legal forms of entrepreneurial organization. Intellectual Property: Trademark, Copyright, Patents, Geographical Indications (GI) of goods, Design.

RECOMMENDED BOOKS:

1. Chandra, P.." *Fundamentals of financial management"*, 6th Edition, Publisher, 2014.

2. Kotler,P. *Marketing management*, 15th Edition, New Delhi: Prentice Hall of India Publications , 2016

3. VSP Rao,"Human Resource Management", 3rd Edition, Text & Cases Excel Books, 2010

4. B.Mahadevan, "Operation Management" ,3rd Edition, Pearson, NewDelhi, 2015

REFERENCE BOOKS:

1. Robert D Hisrich, Michael P Peters, Dean A Shepherd, "Entrepreneurship",6th Edition.McGraw-Hill Education,2013.
2. Kuratko. Donald F &Hodgetts, Richard M ,"Entrepreneurship",.New Delhi: Thomson, 2007.
3. Rajeev Roy ,"Entrepreneurship" Edition, Oxford higher education,2009
4. P.Narayana Reddy, "Entrepreneurship text and cases",Cengage Learning 1 edition 2010.

FOUNDRY AND FORGING LABORATORY

Sub Code: ME351	L:T:P	Total Lecture Hrs :30
Exam Marks: 100	Hrs/week : 0:0:3	Exam Hours : 03

PART – A

Testing of Moulding sand and Core sand
Preparation of sand specimens and conduction of the following tests:

1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Core hardness & Mould hardness tests.
4. Sieve Analysis to find Grain Finest number of Base Sand
5. Clay content determination in Base Sand

PART – B

Foundry Practice

1. Use of foundry tools and other equipments.
2. Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).
3. Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

Forging Operations

1. Calculation of length of the row material requited to do the model.
2. Preparing minimum three forged models involving upsetting, drawing and bending operations.
3. Out of these three models, at least one model is to be prepared by using Power Hammer.

REFERENCE BOOKS:

1. Elements of work shop technology vol1 by Hajra choudary
2. Foundry technology by Sinha and Goel
3. Foundry engineering by R.B Gupta
4. Modern foundry practice by F.Howard
5. Foundry by Rossi Nott

SEMESTER IV

MATHEMATICS IV

Sub Code: ME431	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

COURSE DESCRIPTION:

This course contains five units which are Numerical Methods, Complex Variables, Series Solution of Differential Equation and Special Function with Statistics and Probability. This paper emphasizes the basic concepts and methods of probability, discrete and continuous random variables are considered.

COURSE OBJECTIVE:

The course aims to develop the skills of the students in the areas of all engineering. This will be necessary for their effective studies in a large number of engineering subjects and able to apply and solve problems arising in applications. The course will also serve as a prerequisite for post graduate and specialized studies and research.

COURSE OUTCOMES:

At the end of the course students will be able to

- Solve first and second order initial value problems by Taylor series, modified Euler and Fourth order Runge – Kutta method, Milne's and Adam Bashforth methods, find the derivatives of functions at particular point numerically by Newton's interpolation method, evaluate the definite integrals by Simpson's one third, three eighth and Weddle's rule.
- Construct an analytic function by Milne's method, evaluate contour integrals by Cauchy's integral formula.
- Solve nonlinear second order Bessel's and Legendre's differential equations by power series method.
- Find probability distribution of discrete and continuous random variables, fit the linear and quadratic curves by least square methods, establish correlation and regression for the given data.
- Solve one dimensional heat and wave equations and two dimensional Laplace equations by finite difference method.

UNIT- I: Numerical Methods - II **12 Hour**

Numerical differentiation using Newton's forward and backward interpolation formulae. Numerical Integration- Simpson's one third and three eighth's value, Weddle's rule. (All formulae / rules without proof)

Numerical solutions of first order and first degree ordinary differential equations : Taylor series method – modified Euler methods – Fourth order Runge – Kutta method for solving

first and second order equations.Milne's and Adams - Bashforth predictor and corrector methods (All formulae without Proof).

UNIT- II: Complex Variables **14 Hours**

Analytic functions, Cauchy – Riemann equations in Cartesian and polar forms, Properties of analytic functions. Conformal transformation – $W = z^2$, $W = e^z$, $W = z + \frac{1}{z}$, Bilinear transformations.

Cauchy's theorem, Cauchy's integral formula. Taylor's and Laurent's series (Statements only) Singularities, Poles, Residues, Cauchy's residue theorem (statement only)

UNIT- III: Series solution of Ordinary Differential Equations and Special Functions 10 Hours

Series solution – Frobenius method, Series solution of Bessel's D.E. leading to Bessel function of fist kind.Equations reducible to Bessel's D.E., Series solution of Legendre's D.E. leading to Legendre Polynomials. Rodirgue's formula

UNIT- IV: Probability & Statistics **14 Hours**

Random variables – Discrete and continuous random variables. Probability mass function (pmf), Probability density function (pdf), cumulative distribution function (cdf), mean, variance,

Theoretical distribution - Binomial, Poisson, Normal and Exponential distributions.

Curve fitting by the method of least squares: $y = a + bx$, $y = a + bx + cx^2$, $y = ax^b$, $y = ab^x$, $y = ae^{bx}$, Correlation and Regression

UNIT – V: Numerical Techniques to solve Partial Differential Equations **10 Hours**

Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

TEXT BOOK:

1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, June 2014.

2. Murray R. Spiegel, John Schiller, R. Alu Srinivasan, "Theory and Problems of Probability and Statistics", Schaum's series, Tata-Macgraw Hill, 2004.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, Inc., 2011
2. B.V. Ramana, "Higher Engineering Mathematics", 6th Reprint, Tata-Macgraw Hill, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education.
4. Sheldon M. Ross, "Introduction to Probability Models", 9th Edition, Academic Press, 2008
5. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Process", Academic Press, 2007

APPLIED THERMODYNAMICS

Sub Code: ME432	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:1:0	Exam Hours : 03

Course Description:

Provides advanced knowledge about applications of thermodynamics in the field of mechanical engineering.

Course Objectives:

- To make the students understand thermodynamic principles, in various applications involving machines converting heat in to work and work in to heat. Some of such applications covered in this course are

a) Steam engines
b) Gas turbine and jet propulsion
c) Compressors
d) Refrigerators and air conditioners

- To quantify the behavior of power plants based on the Rankine cycle, including the effect of enhancements such as superheat, reheat and regeneration;
- To quantify the performance of power plants based on the Brayton cycle, including the effects of enhancements such as reheat, regeneration and intercooling;
- To quantify the performance of refrigeration and heat pumps

Level of knowledge: Basic of Thermodynamics

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Determine the properties of steam using Mollier chart and steam calorimeters

CO2: Explain the principles of vapour power cycles and gas power cycles using first principle

CO3: Explain jet propulsion system using principles of turboprop and turbojet principles

CO4: Compare rotary and reciprocating compressors using first principle

CO5: Evaluate the psychometric properties of refrigerant using psychometric charts

UNIT-I **10 Hours**

PROPERTIES OF PURE SUBSTANCES. Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-V, T-S and Mollier diagram for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined). Non-flow and Steady flow vapour processes, Change of properties, Work and heat transfer.

VAPOUR POWER CYCLE Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle.

UNIT-II **10 Hours**

GAS POWER CYCLE AND GAS TURBINE

Classification of Gas Turbines, Analysis of open cycle gas turbine cycle.Advantages and Disadvantages of closed cycle. Work done, condition for maximum work, methods to improve thermal efficiency.

JET PROPULSION: Introduction to the principles of jet propulsion, Turbojet and turboprop engines & their processes, Principle of rocket propulsion, Introduction to Rocket Engine.

UNIT-III **10 Hours**

RECIPROCATING COMPRESSORS: - Operation of a single stage reciprocating compressors. Work input through p-v diagram. Effect of clearance and volumetric efficiency.Adiabatic, isothermal and mechanical efficiencies.Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression.

ROTARY COMPRESSORS - Vane compressor, roots blower - Comparison between reciprocating compressors and rotary compressors.

UNIT - IV **10 Hours**

REFRIGERATION: History and applications, air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle. Vapour absorption refrigeration system. Steam jet refrigeration.

VAPOUR COMPRESSION REFRIGERATION; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP. Refrigerants and their desirable properties

UNIT - V **10 Hours**

PSYCHOMETRICS:

Atmospheric air and psychometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures, specific and relative humidifies and the relation between the two Enthalpy and adiabatic saturation temperature. Problems without charts only

AIR CONDITIONINIG

Construction and use of psychometric chart.Analysis of various processes; heating, cooling, dehumidifying and humidifying.Adiabatic mixing of stream of moist air. Summer and

winter air - conditioning. Problems using charts only

TEXT BOOKS:

1. P.K.Nag,"Basic and Applied Thermodynamics"Tata McGraw Hill Pub. Co., 10thEdition , 2009

2. G.J. Van Wylen and R.E.Sonntag,"Fundamental of Classical Thermodynamics", 4th Edition edition,John Wiley & Sons,14 June 1994

REFERENCE BOOK

1. Yunus, A.Cenegal and Michael A.Boles,"Thermodynamics -An Engineering Approach", 8th edition, Tata McGraw Hill Pub. Co., 2014

2. R.K.Hegde and Niranjan Murthy ,"Applied Thermodynamics", Sapna Book House,2009

KINEMATICS OF MACHINES

Sub Code: ME433	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course objective:

- Comprehend the fundamentals of kinematics. And to understand the concept of machines, mechanisms and related terminologies.
- To make the students become familiar and understanding of the most commonly used mechanisms (4-bar, 6-bar linkages, gear trains and cams).
- To equip students with skills to formulate the concept of synthesis and analysis of different mechanisms. To understand the Principles and working of various straight line motion mechanisms
- To reviews and reinforces the student's understanding of Kinematics of multi body systems with immediate application to the study of machines.

Level of understanding: Basic**.**

Course outcomes:

Upon completion of this course, the students will be able to
CO1: Analyse velocity and acceleration parameters in various four bar mechanisms using instantaneous centre method and relative velocity method
CO2: Explain the fundamentals of gear profiles and extrapolate various parameters of Spur gear teeth
CO3: Design gear trains for power transmission
CO4: Develop the displacement diagram for a required output and design cam profiles for inline and offset followers

UNIT-I **10 Hours**

INTRODUCTION: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine.

KINEMATIC CHAINS AND INVERSIONS: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

MECHANISMS: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism.

Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.

UNIT-II **09 Hours**

VELOCITY IN MECHANISMS (INSTANTANEOUS CENTRE METHOD):

Introduction - Space and Body Centrodes - Methods for Determining the Velocity of a Point on a Link - Velocity of a Point on a Link by Instantaneous Centre Method - Properties of the Instantaneous Centre - Number of Instantaneous Centres in a Mechanism - Types of Instantaneous Centres - Location of Instantaneous Centres - Aronhold Kennedy (or Three Centres in Line) Theorem - Method of Locating Instantaneous Centres in a Mechanism – Relative Velocity Method-Problems.

ACCELERATION IN MECHANISMS:

Introduction - Acceleration Diagram for a Link - Acceleration of a Point on a Link - Acceleration in the Slider Crank Mechanism - Coriolis Component of Acceleration – Problems.

UNIT-III **10 Hours**

FRICTION: Types of Friction - Screw Friction- Screw Jack - Torque Required to Lift the Load by a Screw Jack - Efficiency of a Screw Jack - Maximum Efficiency of a Screw Jack – Problems.

FRICTION CLUTCHES - Single Disc or Plate Clutch - Multiple Disc Clutch - Cone Clutch - Centrifugal Clutches – Problems.

UNIT-IV **10 Hours**

FRICTION WHEELS: Introduction - Advantages and Disadvantages of Gear Drive - Classification of Toothed Wheels - Terms Used in Gears - Law of Gearing - Velocity of Sliding of Teeth - Forms of Teeth - Cycloidal Teeth - Comparison Between Involute and Cycloidal Gears - Length of Path of Contact - Length of Arc of Contact - Contact Ratio - Interference in Involute Gears - Minimum Number of Teeth on the Pinion, gear wheel in Order to Avoid Interference - Minimum Number of Teeth on a Pinion for Involute Rack in Order to Avoid Interference.

GEAR TRAINS: Introduction - Types of Gear Trains - Simple Gear Train - Compound Gear Train - Design of Spur Gears - Reverted Gear Train - Epicyclic Gear Train - Velocity Ratio of Epicyclic Gear Train - Compound Epicyclic Gear Train (Sun and PlanetWheel) - Epicyclic Gear Train With Bevel Gears - Torques in Epicyclic Gear Trains.

UNIT-V **09 Hours**

CAM: Introduction - Classification of Followers - Classification of Cams - Terms used in Radial cams - Motion of the Follower - Displacement, Velocity and Acceleration Diagrams when the Follower Moves with Uniform Velocity - Simple Harmonic Motion (SHM) - Uniform Acceleration and Retardation - Cycloidal Motion - Construction of Cam profiles.

TEXT BOOKS

1. Ratan.S.S, "Theory of Machines", 4th Edition, Tata McGraw Hill Publishing company Ltd., 2014

2. Khurni.R.S and Gupta.J.K, "Theory of Machines", 14th Revised edition, S Chand, 2005

REFERENCE BOOKS

1. Shigley.J.E and Uicker.J. J, "Theory of Machines and Mechanisms", 4th edition, McGraw Hill, 2014

2. Ghosh.A and Mallick.A.K, "Theory of Mechanisms and Machines", 3rd edition, Affiliated East-West Pvt Ltd., New Delhi, 1998.

3. Rao.J.S, and Dukkipati.R.V, "Mechanism and Machine Theory", 2nd Edition, Wiley-Eastern Ltd., NewDelhi, Reprint 2006

PRIMARY MANUFACTURING

Sub Code: ME434	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:2	Exam Hours : 03

COURSE DESCRIPTION: This course provides the basic knowledge about manufacturing techniques, selection of suitable machine and a cutting tool for a specific application. A thorough discussion on machine tools involving mechanism and principle of working are explained elaborately with the help of merchant circle diagram. The concept of casting and welding are also included to understand the possibility of a process in a certain direction.

COURSE OBJECTIVES:

- 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….

Level of Learning: Basic.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Classify the manufacturing processes and identify the basic requirements for the casting process.
CO2: Explain the welding techniques and suggest special welding techniques in the relevant areas.
CO3:Describe the mechanics of cutting principles, tool materials and cutting conditions.
CO4: Summarize the various lathe, shaping, planning and drilling operations
CO5: Explain the concept of Grinding and finishing processes and their applications
CO6: Demonstrate the various lathe, shaping, milling and grinding operations

UNIT – I **10 Hours**

INTRODUCTION TO CASTING PROCESS: Concept of manufacturing process, its importance & classification. Introduction to casting process, steps involved in casting, varieties of components produced by casting process, advantages & limitations of casting process.

Patterns: Definition, functions, classification of patterns, materials used for pattern, various pattern allowances and their importance.

Binder & Additives: Definition, types of binder & additives used in molding sand.

SAND AND METAL MOLDS: Requirement of base sand, molding sand mixture ingredients (base sand, binder & additives) for different sand mixtures.

Cores: Definition, need, types, method of making cores.

Concept of Gating & Riser: Principle and types.

Fettling and cleaning of castings: Basic steps, casting defects, causes, features and remedies.

Molding Machines: Jolt & Squeeze type and Sand slinger.

Melting Furnaces: Classification of furnaces, cupola furnace.

Metal molds: Gravity die-casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting and continuous casting processes.

UNIT – II **10 Hours**

WELDING PROCESS: Definition, Principles, Classification, Application, Advantages & limitations of welding.Concept of electrodes, filler rod and fluxes.

Arc Welding: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding) (SAW) and Atomic Hydrogen Welding processes. (AHW)

Special types of welding: Working principle, advantages, limitations and applications of Resistance welding, Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.

METALLURGICAL ASPECTS IN WELDING: Structure of welds, Formation of different zones during welding. Heat Affected Zone (HAZ).Parameters affecting HAZ. Effect of carbon content on structure and properties of steel. Shrinkage in welds & Residual stresses.

Welding defects: Detection causes & remedy.

Inspection Methods: Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.

UNIT – III **10 Hours**

THEORY OF METAL CUTTING: Single point cutting tool nomenclature, tool geometry, orthogonal & oblique cutting. Mechanics of chip formation process, types of chips. Merchant's circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, numerical on Merchant's analysis. Tool Wear, forms of tool wear, wear mechanisms of

cutting tools, Tool failure, tool life. Effects of cutting parameters on tool life, Tool failure criteria, Taylor's Tool life equation, numerical on tool life equation.

CUTTING TOOL MATERIALS: Desired properties and types of cutting tool materials – HSS, carbides, coated carbides, ceramics.Cutting fluids - Desired properties, types and selection.Heat generation in metal cutting, factors affecting heat generation.Heat distribution in tool and workpiece and chip.Measurement of tool tip temperature.

UNIT – IV **09 Hours**

LATHE, SHAPER AND PLANER: Classification, constructional features, Tool Layout of Turret & Capstan Lathe, horizontal shaper and double housing planer. Driving mechanisms, different operations on lathe, shaper and planer machines, numerical on machinery time calculations

DRILLING MACHINE: Classification, constructional features of upright, multiple spindle, deep hole & automatic drilling machine. Types of drill & drill bit nomenclature, drill materials, numerical on drilling. Introduction to CNC machines, Principles of operation, Axes of NC machine, Coordinate systems, basics of Manual part programming methods.

UNIT - V **08 Hours**

MILLING MACHINE: Classification, constructional features of bed type, planer, special purpose milling machine, milling cutter nomenclature. Indexing, indexing mechanism, Simple, compound, differential and angular indexing calculations, numerical on simple and compound indexing

GRINDING MACHINE & FINISHING PROCESSES: Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types, selection of grinding wheel, grinding process parameters, Dressing and truing of grinding wheels. Broaching process - Principle of broaching.Details of a broach.Types of broaching machines-constructional details.Applications.Advantages and Limitations. Laping and Honing operations – Principles, arrangement of set up and application. Super finishing process, polishing, buffing operation and application, Micro-machine tools.

LAB COMPONENT:

PART – A

Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper.

Cutting of Gear Teeth using Milling Machine.

Surface Grinding

TEXT BOOKS

1. J. P. Kaushish, "Manufacturing Processes", 2nd edition, Prentice-Hall of India Pvt.Ltd; August 2010, ISBN-13: 978-8120340824

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

3. Milton C. Shaw. "Metal Cutting Principles", Oxford University Press,2012.
4.Choudhury S K, "Elements of Workshop Technology" , 13 edition, Vol 2 Machine Tools, Indian Book Distributing Company Calcutta, 2010;, ISBN-8185099154, 9788185099156

REFERENCE BOOKS

1. Steven R Schmid , Serope Kalpakjian, "Manufacturing Engineering and Technology" ,Pearson publication, 2014.
2. Geoffrey Boothroyd,"Fundamentals of Metal Machining and Machine Tools", Third Edition,CRC Press, 1988, ISBN 0824778529, 9780824778521.

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

FLUID MECHANICS

Sub Code: ME435	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:0:2	Exam Hours : 03

Course Description: Fluid Mechanics concerns the continuous deformation of fluids under shear stress. It emphasizes on establishing the properties of fluids and introduces hydrostatic principles before delving into dynamics of flow for incompressible fluids such as water. This course concerns with formulating and solving problems of hydrostatics, control volume analysis, the Bernoulli equation, pipe flow, dimensional analysis, boundary layers, fluid forces in flow, and flow over immersed objects

Course Objectives:

- Develop an understanding of fluid dynamics in Fluid/aerospace engineering as well as a variety of other fields.
- Learn to use control volume analysis to develop basic equations and to solve problems.
- Understand and use differential equations to determine pressure and velocity variations in internal and external flows.
- Understand the concept of viscosity and where viscosity is important in real flows.
- Learn to use equations in combination with experimental data to determine losses in flow systems.
- Learn to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: To Develop an understanding of fluid dynamics in Fluid/aerospace engineering as well as a variety of other fields.
CO2: To Learn to use control volume analysis to develop basic equations and to solve problems.
CO3: To Understand and use differential equations to determine pressure and velocity variations in internal and external flows.
CO4: To Understand the concept of viscosity and where viscosity is important in real flows.
CO5: To Learn to use equations in combination with experimental data to determine losses in flow systems.
CO6: To Learn to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity.

Prerequisite: Basic Science

UNIT-I **10 Hours**

PROPERTIES OF FLUIDS: Introduction, Properties of fluids, viscosity, Stroke's Theorem, Compressibility, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation

FLUID STATICS: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and centre of pressure

UNIT-II **10 Hours**

BUOYANCY: Archimedes's Principle, Buoyancy, centre of buoyancy, metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of Metacentric height experimentally and theoretically

FLUID KINEMATICS: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Coordinates only, velocity and acceleration, velocity potential function and stream function, Streamlines, Path lines, Streak lines and Stream tubes, Circulation and Vorticity

UNIT-III **10 Hours**

FLUID DYNAMICS: Introduction to Navier-Stoke's equation, Introduction equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation

FLUID FLOW MEASUREMENTS: Venturimeter, orifice meter, Pitot tube, V-Notch and rectangular notches

UNIT-IV **10 Hours**

DIMENSIONAL ANALYSIS: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham pi theorem, dimensionless numbers, similitude, types of similitudes (Problems only on similitudes)

EXPERIMENTAL FLUID MECHANICS: Objective of experimental studies, Fluid mechanics measurements, Measuring instruments, Performance terms associated with measurement systems, Direct measurements, Analogue methods, Flow visualization, Components of measuring systems

UNIT-V **10 Hours**

INTERNAL AND EXTERNAL FLOWS: Flow through pipes, Hagen-Poiseuille equation, Minor losses through pipes. Darcy's and Chezy's equation for loss of head due to friction in pipes, Flow past immersed bodies-Drag, Lift, expression for lift and drag and their coefficients, wake and separation, boundary layer concept, displacement, momentum and energy thickness

INTRODUCTION TO COMPRESSIBLE FLOW: Velocity of sound in a fluid, Mach number, Mach cone, Mach angle and Mach wave, propagation of pressure waves in a compressible fluid

LAB COMPONENTS: **30 Hours**

1. Determination of coefficient of friction of flow in a pipe.

2. Determination of minor losses in flow through pipes.

3. Determination of force developed by impact of jets on vanes.

4. Calibration of flow measuring Devices like

   a) Orifice Plate Meter
   b) Nozzle
   c) Venturimeter
   d) V-notch

TEXT BOOKS:

1) Bansal. R.K, "Fluid Mechanics and Hydraulics Machines", 9th edition, Laxmipublications (P) Ltd., New Delhi,2017

REFERENCE BOOKS:

1. White. F.M, "Fluid Mechanics", Tata McGraw-Hill, 8th Edition, New Delhi, 2016
2. Streeter V.L., Benjamin Wylie, "Fluid Mechanics", Mc Graw Hill Book Co., New Delhi,1999
3. Robert W. Fax, Philip J. Pritchard, Alan T. McDonald, "Introduction to Fluid Mechanics", 8th Edition, Wiley India Edition, Wiley Student, 2014
4. Modi P.N, & Seth S.M, "Hydraulics and Fluid Mechanics", 14th edition, Standard Book House,New Delhi, 2002
5. Shiv Kumar, "Fluid Mechanics & Fluid Machines: Basic Concepts & Principles", Ane Books Pvt. Ltd., New Delhi, 2010
6. Yunus A Cengel & John M. Cimbala, "Fluid Mechanics",3Edition, Tata McGraw Hill, New Delhi, 2013

ENGINEERING METROLOGY

Sub Code: ME436	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:2	Exam Hours : 03

Course Description: Provides basic knowledge about evolution of standards, Classification and its application. It throws a light on development of standards. It equips the readers to calibrate the standards and to acquire knowledge about various Sensors used for measuring mechanical parameters and Telemetry.

Course Objectives: To familiarize with

The students will possess the knowledge and skills in

- The general concepts and terminologies of Measurement system, Evolution of measurement.
- Concept of measurement and measurand, Flow diagram of measurement, Static and Dynamic characteristics of measurement system.
- Concept of Transducer, Classification and Performance Characteristics of transducers.
- Principles of calibration- definition, traceability, dead beat readings.

Level of Knowledge: Basic

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Examine the Line standards by slip gauges

CO2: Detect the screw thread parameters and to operate the LVDT equipment

CO3: Interpret the parameters of Cathode ray oscilloscope

CO4: Operate & infer the values of Torque measurement equipment

CO5: Compute the strain from the strain gauge equipment.

UNIT-I **10 Hours**

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.

SYSTEM OF LIMITS, FITS, TOLERANCE AND GAUGING: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS919-1963), geometrical tolerance, positional-tolerances, hole basis system, shaft basis system, classification of gauges, brief concept of design of gauges (Taylor's principles), Wear

allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

UNIT-II **10 Hours**

COMPARATORS AND ANGULAR MEASUREMENT: Introduction to comparators, characteristics, classification of comparators, mechanical comparators-dial indicator, optical comparators-principles, Zeiss ultra optimeter, electric and electronic comparators-principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Angular measurements, bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges clinometers.Coordinate Measurement Machine- Architecture & Operation, Laser Interferometer, Angle Dekkor

INTERFEROMETER AND SCREW THREAD, GEAR MEASUREMENT: Interferometer, interferemetry, autocollimator. Optical flats. Terminology of screw threads, measurementof major diameter, minor diameter, pitch, angle and effective diameter of screw threadsby 2-wire and 3-wire methods, best size wire. Tool maker's microscope, gear.to.,terminology, use of gear tooth vernier caliper,Gleason Gear Testing Machine

UNIT-III **09 Hours**

MEASUREMENTS AND MEASUREMENT SYSTEMS: 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.

RECEIVING DEVICES & ADVANCES IN METROLOGY: 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), Nanometrology

UNIT-IV **09 Hours**

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

UNIT-V **09 Hours**

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.

LAB COMPONENT: **30 Hours**

Part-A: Mechanical measurements

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

Part-B: Metrology

1. Measurements using Optical Projector / Toolmaker Microscope.

2. Measurement of angle using Sine Center / Sine bar / bevel protractor

3. Measurement of alignment using Autocollimator / Roller set

4. Measurement of cutting tool forces using

   a. Lathe tool Dynamometer
   b. Drill tool Dynamometer.

5. Measurement of Screw thread Parameters using Two wire or Three-wire method.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer

8. Calibration of Micrometer using slip gauges

9. Measurement using Optical Flats

TEXT BOOKS:

1. Thomas G. Beckwith , Roy D. Marangon, John H. Lienhard ,"Mechanical Measurements", 6th Edition, Pearson education, 2014

2. R K Jain, "Engineering Metrology",17thEdition, ISBN: 717409024X; ©1999 Khanna Publications Delhi; 2009

3.Connie L Dotson,"Fundamentals of Dimensional Metrology" 5th edition, Delmar Cengage Learning, 2006

REFERENCE BOOKS

1. I C Gupta,"A Text Book Of Engineering Metrology",7th Edition, Dhanpat Rai Publications (P) Ltd.-New Delhi,
2. Jerry Faulk, Al Sutko,"Industrial Instrumentation"1st Edition, ISBN-13: 978-0827361256, Thompson Asia Pvt. Ltd.2002.
3. Ernest, "Measurement Systems Application", 1st Edition, ISBN-13: 978-0070173385, McGraw-Hill Book Company.
4. R.S.Sirohi,"Mechanical measurements"3rd Edition, ISBN-8122403832, New Age Publications, 1991.
5. J.F.W. Galyer, Charles Reginald Shotbolt, "Metrology for Engineers" 5th Edition, Mc Donald & Co Publications, 2005.

COMPUTER AIDED MACHINE DRAWING

Sub Code: ME437	**L:T:P**	**Total Lecture Hrs :60**
Exam Marks: 100	**Hrs/week : 2:4:0**	**Exam Hours : 03**

Course Description: Gives knowledge on 2d drawing and 3d modeling.

Course Objectives:

- To visualize an object and convert it into a drawing.
- To gain knowledge of conventional representation of various machining and mechanical details as per IS.
- To become conversant with 2-D and 3-D drafting.
- Gaining the knowledge of CAD software and its features for effective representation of machine components and their assembly.
- Understand the format and Standards of Machine Drawing.
- Understand the technical information on machine drawings.
- Understanding and drawing of various views and machine components.
- Learning how to assemble and disassemble important parts used in major mechanical engineering applications.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: Students will be able to understand the concept and importance of limits fits and tolerance in the manufacturing drawing.
CO2: Students will be able to understand the thread terminologies, different types of fasteners, keys and joints and couplings used in machine parts.
CO3: Student will be able to perform both 2D to 3D drawings of any components using the modelling software.
CO4: Students will be able to visualize and model different parts of a machine.
CO5: Students will be able to construct assemblies of various machines like screw jack, machine vice, tail stock of lathe from the concepts learnt using the modelling software.

INTRODUCTION:

Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap.

PART-A

UNIT I **10 Hours**

SECTIONS OF SOLIDS: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections.

ORTHOGRAPHIC VIEWS: Conversion of pictorial views into orthographic projections. of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions.Precedence of lines.

UNIT II **08 Hours**

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.

PART-B

UNIT III **08 Hours**

KEYS &JOINTS : Parallel key, Taper key, Feather key, Gibhead key and Woodruff key

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.

UNIT IV **08 Hours**

COUPLINGS: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

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.

PART – C **26 Hours**

Assembly Drawings

(Part drawings should be given)

1. Plummer block (Pedestal Bearing)

2. Rams Bottom Safety Valve

3. I.C. Engine connecting rod

4. Screw jack (Bottle type)

5. Tailstock of lathe

6. Machine vice

7. Tool head of the shaper

TEXT BOOKS:

1. N.D.Bhat & V.M.Panchal,'A Primer on Computer Aided Machine Drawing-2007',VTU, Belgaum, 'Machine Drawing', 2012.

REFERENCE BOOKS

1. S. Trymbaka Murthy,'A Text Book of Computer Aided Machine Drawing',CBS Publishers, New Delhi, 2007
2. K.R. Gopala Krishna,'Machine Drawing', Subhash Publication,2012.
3. Goutam Pohit & Goutham Ghosh,'Machine Drawing with Auto CAD',1st Indian print Pearson Education, 2007
4. 'Auto CAD 2015, for engineers and designers', Sham Tickoo. Dream tech 2015
5. 'Machine Drawing', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata Mc GrawHill,2006
6. Alex Krulikowski ,"Fundamentals of Geometric Dimension & Tolerancing",6 edition , Goodheart-Willcox Pub ,25 November 2014

HOLISTIC EDUCATION-IV

Sub Code: HE471	**L:T:P**	**Total Lecture Hrs :12**
Exam Marks: 100	**Hrs/week : 1:0:0**	**Exam Hours : 03**

Course Description: This course contains three units which are Personal skills, Inter-personal Skills and Societal Skills.

Course Objectives:

- Holistic development of the individual adult in every student
- Knowing life and its principles
- Broadening the outlook to life
- Training to face the challenges of life
- Confidence creation and personality development
- Emotional control and stress management
- Creating awareness on duties, rights and obligations a s member of the Society
- Realizing Personal Freedom-its limits and limitations
- Developing the attitude to be a contributor and giver
- Realizing the real happiness in life

Level of Knowledge: Basic

Personal skills **04Hours**

Stress management

Scientific temper

Interpersonal skills **04Hours**

Change management

Networking and PR skills

Societal skills **04Hours**

Selected areas of the constitution

REFERENCE BOOKS

1. "Modules on Holistic development" (Prepared by Core committee, CHRIST (Deemed to be University)College)
2. Bradley C. McRae, "Practical Time management", International self-counsel Press Ltd., 2001
3. Ronald. B., Adler &Jeanne M. Elmhorst, "Communicating at work–Principles and practice for business and professions", McGraw Hill

SEMESTER V
DESIGN OF MACHINE ELEMENTS

Sub Code: ME531	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Many mechanical design, invention, and engineering tasks involve a knowledge of various machine elements and an intelligent and creative combining of these elements into a component or assembly that fills a need.

Course Objectives:

This course "Design of Machine Elements -I" is designed with the following 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. Eg., fasteners, shafts, couplings etc. and will be able to design these elements for each application.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: To learn to use standard practices in design of machine elements and standard data
CO2: Apply basic stress and strain analysis techniques to machine elements
CO3: Utilize standard failure theories and fatigue analysis to develop safety factors for machine elements
CO4: Function effectively within engineering work teams

UNIT- I **10 Hours**

INTRODUCTION: 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.

DESIGN FOR STATIC & IMPACT STRENGTH:

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.

UNIT – II **10 Hours**

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.

UNIT – III **10 Hours**

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.

UNIT – IV **10 Hours**

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.

UNIT – V **09 Hours**

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.

ESSENTIAL READINGS:

1. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke.

McGraw Hill International edition, 6 th Edition 2009.

2. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing

Company Ltd., New Delhi, 3rd Edition first reprint 2010.

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 Shashi Prakashan, "Design Data Hand Book", Belgaum. Reprint, I K International Publishing house, 2011

REFERENCE BOOKS

1. Robert L. Norton, "Machine Design", 3rdImpression , Pearson Education Asia, 2008.
2. 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.
3. Hall, Holowenko, Laughlin, "Machine Design", Special Indian Edition, Schaum's Outlines series, Tata McGraw Hill Publishing Company Ltd., 2010.
4. Robert C. Juvinall and Kurt M Marshek, "Fundamentals of Machine Component Design", 5th Edition, Wiley India Pvt. Ltd., 2012.

DYNAMICS OF MACHINERY

Sub Code: ME533	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Concerned with the study of forces and torques and their effect on motion, as opposed to kinematics, which studies the motion of objects without reference to its causes. Isaac Newton defined the fundamental physical laws which govern dynamics in physics, especially his second law of motion.

Course Objectives:

- To enhance students knowledge on planar kinematic analyses of rigid body systems
- To teach students concepts of planar, inverse, Newtonian dynamic analyses of Mechanisms and machines
- To teach students concepts of planar, inverse, Newtonian dynamic analyses
- of fixed-axis rotation of non-symmetric bodies
- To teach students concepts of static and dynamic mass balancing and flywheels
- To teach students concepts of generalized forces and the Principle of Virtual Work

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Explain the static forces of a rigid body by basic laws of physics

CO2: Explain the dynamic forces of a body in motion with basic laws of motion

CO3: Compute dynamic and static force analysis and balancing of rotating masses

CO4: Able to understand and classify different governor by the working principles involved

CO5: Understand gyroscope and cams for engines with knowledge of force

UNIT-I **09 Hours**

Static Force Analysis: Introduction: Static equilibrium. Equilibrium of two and three force members.Members with two forces and torque. Free body diagrams. Principle of virtual work.Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.

UNIT-II **10 Hours**

Dynamic Force Analysis: D'Alembert's principle, Inertia force, inertia torque. Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems.Turning moment diagrams and flywheels.Fluctuation of Energy.Determination of size of flywheels.

UNIT-III **10 Hours**

Balancing of Rotating Masses: Static and dynamic balancing.Balancing of single rotating mass by balancing masses in same plane and in different planes.Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Radial engine – Direct and reverse crank method.

UNIT-IV **09 Hours**

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives. ratio of belt tensions, centrifugal tension, power transmitted.

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force.stability, sensitiveness. Isochronism, effort and power.

UNIT-V **10 Hours**

Gyroscope: Vectorial representation of angular motion. Gyroscopic couple.Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

Analysis of Cams: Analysis of Tangent cam with roller follower and Circular arc cam operating flat faced and roller followers. Undercutting in Cams

Essential Readings:

1. Sadhu Singh, "Theory of Machines", 4th impression, Pearson Education, 2009.
2. Rattan S.S, "Theory of Machines", 3 rd Edition, Tata McGraw Hill Publishing Company Ltd., 2009.

REFERENCE BOOKS

1. J.J. Uicker, , G.R. Pennock, J.E. Shigley , "Theory of Machines &Mechanisms", 5th edition, OXFORD, 2016
2. A.G.Ambekar, "Mechanism and Machine Theory", PHI Publishers, 2007.

TURBO MACHINES

Sub Code: ME534	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

Course Description:

Provides theory of machines that transfer energy between a rotor and a fluid, including both turbines and compressors. While a turbine transfers energy from a fluid to a rotor, a compressor transfers energy from a rotor to a fluid. The two types of machines are governed by the same basic relationships including Newton's second Law of Motion, laws of thermodynamics and Euler's energy equation for compressible fluids.

Course Objectives:

- To understand the basics of turbomachinery and to identify various types of turbomachinery. To understand the major turbo machinery operations and its basics.
- To understand the 2D and 3D steady flow phenomena in turbo machine components
- Apply the Euler's equation for turbo machinery to analyze energy transfer in turbo machines.
- To compute efficiencies of various turbo machines and to Analyze and select axial-flow turbines and compressors.
- To understand and Analyze and select radial-flow turbo machines for various industrial applications.
- To carry various Performance thermal cycle analysis on turbines.

Prerequisites: Advanced Thermodynamics ME432.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Able to compute power output and power required for a power absorbing and power generating turbo machine.
CO2: Able to compute Degree of reaction, utilisation factor as design inputs for improvising performance and efficiency of Axial/ Radial flow compressor and pump.
CO3: Able to assess performance of isentropic, blade and stage efficiencies in compression, expansion and steam turbine.
CO4: Able to classify and determine the velocity triangles of pelton turbine, francis turbine and Kaplan turbine for maximum efficiency.
CO5: Able to classify and asses the performance of centrifugal pumps, compressor and axial compressors on power developed and stage efficiency.
CO6: Able to test performance of Hydraulic Machines like Kaplan Turbine, Francis, pelton wheel, centrifugal pump and reciprocating pump.

UNIT -I **10 Hours**

INTRODUCTION: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Static and Stagnation states- Incompressible fluids and perfect gases. Expressions for Force, Torque and Power for impact of jets on stationary and moving vanes.Problems.

ENERGY EXCHANGE IN TURBOMACHINES: Euler's turbine equation,Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

UNIT – II **10 Hours**

GENERAL ANALYSIS OF TURBOMACHINES: Radial flowcompressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems.

UNIT – III **10 Hours**

DIMENSIONLESS ANALYSIS AND THERMODYNAMICS OF FLUID FLOW: Dimensionless parameters and their significance, Effect of Reynold's number, Unit and specific quantities, model studies. Thermodynamics of fluid flow: Sonic Velocity and Mach number, Classification of fluid flow based on Mach number. Compression process – Overall isentropic efficiency of compression, Stage efficiency, Comparison and relation between overall efficiency and stage efficiency, Polytropic efficiency, Pre heat factor.Expansion Process – Overall isentropic efficiency for a turbine, Stage efficiency for a turbine, Comparison and relation between stage efficiency and overall efficiency for expansion process, Poly tropic efficiency of expansion. Reheat factor for expansion process.

STEAM TURBINES: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Problems.

UNIT – IV **09 Hours**

HYDRAULIC TURBINES: Classification, Different efficiencies, Pelton turbine – velocity triangles, design parameters, Maximum efficiency. Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters.Problems.

UNIT – V **10 Hours**

CENTRIFUGAL PUMPS: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

CENTRIFUGAL COMPRESSORS: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.

AXIAL FLOW COMPRESSORS: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems.

LAB COMPONENT: **30 Hours**

1. Performance testing of Turbines

   a) Pelton wheel
   b) Francis Turbine
   c) Kaplan Turbines

2. Performance testing of Pumps

   (i) Single stage / Multi stage centrifugal pumps
   (i) Reciprocating pump

3. Performance test of a two stage Reciprocating Air Compressor

4. Performance test on an Air Blower

TEXT BOOKS:

1. V. Kadambi and Manohar Prasad, "An Introduction to Energy Conversion Volume III", New Age International Publishers, 2008.
2. S. M. Yahya, "Turbines, Compressors & Fans", 4th Edition,Tata McGraw Hill Co. Ltd.,2011.

REFERENCE BOOKS

1. D. G. Shepherd, "Principals of Turbomachines", The Macmillan Company, 2007.
2. S. L. Dixon, "Fluid Mechanics & Thermodynamics of Turbomachines", 5th Edition, Elsevier, 2005.
3. B.K.Venkanna, "Turbomachine", PHI Publishers, 2009.

INTERNAL COMBUSTION ENGINES

Sub Code: ME535	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:2	Exam Hours : 03

Course Description: This Course is designed to provide detailed information on working and associated topics on internal combustion engines, an important type of heat engine. Combustion chemistry, fuels, combustion and ignition, combustion chamber design, pollution and few modern engine developments are main contents

Course Objective:

- To make students familiar with the design and operating characteristics of modern internal combustion engines
- To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines
- To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions
- To introduce students to the environmental and fuel economy challenges facing the internal combustion engine
- To introduce students to future internal combustion engine technology and market trends

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: To make students familiar with the design and operating characteristics of modern internal combustion engines

CO2: To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines

CO3: To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions

CO4: To introduce students to the environmental and fuel economy challenges facing the internal combustion engine

CO5: To introduce students to future internal combustion engine technology and market trends

UNIT - I. **10 Hours**

BASIC CONCEPTS AND COMBUSTION THERMODYNAMICS

BASICS OF IC ENGINES Heat Engine, IC and EC engines, I.C. Engine construction – Applications , Engine nomenclature, Engine classification, 2 and 4 stroke operations, Valve and port timing diagram.

COMBUSTION THERMODYNAMICS: Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, actual combustion. Exhaust gas analysis. A/F ratio.Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion.Combustion efficiency.

UNIT - II **09 Hours**

IC ENGINE CYCLES

FUEL AIR CYCLE AND ACTUAL CYCLE Fuel air cycle, Assumptions, Comparison with air standard cycle, Carnot cycle and efficiency. Actual cycle and various losses Study of Otto cycle Diesel cycle Dual cycle-equations for efficiency, mean effective pressure and comparison of cycles

UNIT - III **10 Hours**

SI ENGINES

COMBUSTION IN SI ENGINE, Flame speed, Ignition delay, abnormal combustion and it's control, combustion chamber design for SI engines. Carburetion, Mixture requirements, Carburetor types Theory of carburetor, MPFI.

IGNITION SYSTEM requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition, battery and its types, Charging and discharging of batteries

UNIT–IV **09 Hours**

CI ENGINE:

COMBUSTION IN CI ENGINES, Ignition delay, Knock and it's control, Comparison of SI and CI engine combustion. Combustion chamber design of CI engines.

FUEL INJECTION IN CI ENGINES, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings.

UNIT–V **09 Hours**

FUELS FOR SI AND CI ENGINE, important qualities of SI engine fuels, Rating of SI engine fuels, Important qualities of CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines. Pollution from IC engines and its control methods

TESTING OF IC ENGINES: Various performance parameters for I.C. Engine – power and methods to measure it, efficiencies, SFC, mean effective pressure, etc. Heat balance sheet.

LAB COMPONENT: **30 Hours**

PART - A

1. Determination of Flash point and Fire point of lubricating oil
2. Determination of Calorific value of fuel
3. Determination of Viscosity of a lubricating oil
4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).

PART - B

Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for

(a) Four stroke Diesel Engine

(b) Four stroke Petrol Engine

(c) Multi Cylinder Diesel/Petrol Engine, (Morse test)

(e) Variable Compression Ratio I.C. Engine.

TEXT BOOKS

1. Heywood, John B, "Internal Combustion Engine Fundamentals", McGraw-Hill, 2007.
2. V Ganesan, "Internal Combustion Engines", 4th edition, Tata McGraw-Hill publishing-
3. company Limited, 2012.
4. Mathur & Sharma, "A Course in International Combustion Engines", 8th edition, Dhanpat Rai & Sons., 1996.
5. Colin R. Ferguson, Allen T Kirkpatrick, "Internal Combustion Engines", 3rd edition, John Wiley & sons, 2016.

REFERENCE BOOKS

1. Edward. F. Obert, "I.C. Engines", Harper International edition, 1973.
2. V Ganesan, "Internal Combustion Engines", 4th edition, Tata McGraw-Hill publishing company Limited, 2012.
3. Willard W. Pulkrabek, "Engineering Fundamentals of the I.C. Engine", 2nd edition, 2013.
4. Lichty, "Combustion Engine Process", 6th edition, Judge, 2000.

ADVANCED MANUFACTURING TECHNOLOGY

Sub Code: ME536	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course provides the advanced knowledge about manufacturing techniques. A thorough discussion on metal forming and powder metallurgy involving mechanism and principle of working are explained elaborately. The concept of friction in metal forming and friction test are also included to understand the possibility of a process in a certain direction.

Course Objectives:

- To study the concepts of latest metal forming techniques and their applications in metal
  forming industry.
- To impart knowledge about principles and criteria of yielding during forming of metals, analysis of different bulk and sheet metal forming processes with different analysis approach.
- To understand the process mechanics with role of different controlling process parameters of various metal forming processes.
- To provide a basic knowledge about advance metal forming techniques such as high velocity forming, extrusion and powder metallurgy.

Level of Learning: Advanced.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Identify various metal forming techniques and suitable processes

CO2: Analyse various stresses developed when engaged with a particular metal forming technique

CO3: Apply knowledge of forging and rolling process gained from the subject of learning

CO4: Compose the drawing and extrusion process to produce a product

CO5: Use the knowledge from high energy rate forming methods

CO6: Understand the concept of 3D printing and additive manufacturing

UNIT – I **10 Hours**

INTRODUCTION TO METAL WORKING PROCESSES: Classification of metal working processes, characteristics of wrought products, advantages and limitations of metal working processes, characteristics of hot and cold metal forming. Effects of metal forming parameters like temperature, strain rate, friction and lubrication, hydrostatic pressure, Deformation zone geometry, workability of materials, Residual stresses in wrought products.

ANALYSIS OF STRESSES AND STRAINS: Concepts of true stress, true strain, triaxial & biaxial stresses. Determination of flow stress, Principal stresses, plane stress & plane strain, Tresca & Von-Mises yield criteria.

UNIT – II **10 Hours**

FORGING PROCESS: Classification of forging processes, Forging machines & equipment.Expressions for forging pressures & load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it.Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. Simple problems.

ROLLING PROCESS: Classification of rolling processes. Types of rolling mills, expression for rolling load. Roll separating force. Frictional losses in bearing, power required in rolling, Effects of front & back tensions, friction, friction hill. Maximum possible reduction.Defects in rolled products.Rolling variables, simple problems.

UNIT – III **10 Hours**

DRAWING PROCESS: Drawing equipment & dies, expression for drawing load by slab analysis, power requirement.Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, Tube drawing, classification of tube drawing, simple problems.

EXTRUSION & SHEET METAL FORMING: Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, Extrusion of seamless tubes. Extrusion variables, simple problem. Sheet Metal forming methods, dies & punches, progressive die, compound die, combination die. Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, LDR in drawing, Forming limit criterion, defects of drawn products, stretch forming. Roll bending & contouring, Simple problems

UNIT – IV **08 Hours**

HIGH ENERGY RATE FORMING METHODS: Principles, advantages and applications, explosive forming, electro hydraulic forming, magnetic pulse forming, petro-forge, drop hammer & dynapak

POWDER METALLURGY: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations.

UNIT – V **09 Hours**

ADDITIVE MANUFACTURING: Fused Deposition Modeling, Selective Laser Sintering, 3D Printing, Laminated Object Manufacturing

JIGS & FIXTURES: Tool design objectives - Materials used in Jigs and Fixtures – Types of Jigs: plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs - Types of Fixtures : boring, lathe, milling and broaching fixtures- Grinding, planning and shaping fixtures

TEXT BOOKS:

1. J. P. Kaushish, "Manufacturing Processes", 2nd edition, Prentice-Hall of India Pvt.Ltd, 2010.
2. Vijay.K. Jain, "Advanced Machining Processes", Allied Publishers Pvt. Ltd., New Delhi.
3. Kalpakjian. S., "Manufacturing Engineering & Technology", Pearson Education Asia.
4. Joshi, P.H., "Jigs & Fixtures", 2nd Edition", Tata McGraw-Hill Publishing Company Limited, 2004.

REFERENCE BOOKS:

1. G.E. Dieter, "Mechanical metallurgy (SI units)", 3rd edition, Mc Graw Hill Publishing Company Limited, 2014.
2. R K Jain, "Production Technology: Manufacturing Processes, Technology and Automation", 17th Edition, Khanna Publishers, 2004.

SIMULATION LABORATORY

Sub Code: ME551	L:T:P	Total Lecture Hrs :30
Exam Marks: 50	Hrs/week : 0:1:2	Exam Hours : 03

Course Objective:

- MATLAB environment and commands
- Linear Algebra and matrices, fundamental engineering computing
- Save, load, display and print commands
- Communication with Excel & 2D and 3D plotting
- Solutions to systems of linear equations
- Conditional statements & Loops
- MATLAB scripts and functions
- Polynomials, including differentiation and integration
- Using MATLAB for simple engineering problems

Course Outcomes:

- By the end of this course, students will be able to:
- Introduce vectors and matrices in MATLAB,
- Apply basic concepts of Linear Algebra for vector and matrix operations,
- Perform 2D and 3D plotting,
- Formulate and solve systems of linear equations by Gaussian elimination, and matrix inversion,
- Write conditional statements and loops,
- Write Scripts and functions in MATLAB,
- Solve some engineering problems using MATLAB,
- Apply the fundamental knowledge of mathematics, science & engineering, to solve the real mechanical engineering problems (through case studies).
- This course is focused on learning programming by using MATLAB to solve mathematical problems. It is divided into two parts.

Part A

1. Introduction to MATLAB: Graphical User Interface (GUI) of MATLAB, Use MATLAB as a sophisticated calculator, Syntax and semantics.

2. Plotting In MATLAB:

Technique to draw the graph of functions in a variety of formats by using MATLAB.Plotting in the plane, plotting the graphs of function, graphs defined by parametric and polar equations. 3-space and investigate the nature of curves and surfaces in space.

3. Matrices and Operations:

Define matrices and vectors, extract parts of them and combine them to form new matrices. How to use operators to add, subtract, multiply and divide matrices.

4. Functions:

Breaking the complex problem into smaller, more manageable parts. We will learn how functions let us create reusable software components that can be applied in many different programs. We will learn how the environment inside a function is separated from outside via a well-defined interface through which it communicates with outside world. We will learn how to define a function to allow input to it when it initiates its execution and output from it when it is done.

5. Loops:

MATLAB's loop construct: The for-loop, if-loop and the while-loop and nested loops.

6. Engineering Mechanics problems:

Initially we will discuss about theoretical background of topic. Further, we will learn how to use MATLAB programming for solving engineering mechanics problems.

REFERENCES BOOKS:

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

SEMESTER VI

DESIGN OF TRANSMISSION SYSTEM

Sub Code: ME631	**L:T:P**	**Total Lecture Hrs :49**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: Many mechanical design, invention, and engineering tasks involve a knowledge of various machine elements and an intelligent and creative combining of these elements into a component or assembly that fills a need.

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. Eg. Gears, Clutches etc. and will be able to design these elements for each application

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Design of shafts under combined loading using ASME codes
CO2: Design of helical, spur, bevel and worm gears under dynamic and wear load, cotter and knuckle joints
CO4: Design of rigid, flexible, flange, Oldham's couplings
CO5: Design of bearings, optimum lubrication required and minimum oil film thickness for bearing lubrication
CO6: Design of piston, connecting rod, crankshaft, Self-locking screw and screw jack

UNIT - I **09 Hours**
DESIGN OF SHAFTS: Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads.

UNIT – II **10 Hours**
SPUR GEARS: Definitions, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load.
HELICAL GEARS: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

UNIT – III **10 Hours**

BEVEL AND WORM GEARS: Bevel Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads. Worm Gears: Definitions, Design based on strength, dynamic, wear loads and efficiency of worm gear drives.

IC ENGINE PARTS: Design of piston, connecting rod and crank shaft.

UNIT – IV **10 Hours**

COTTER AND KNUCKLE JOINTS, KEYS AND COUPLINGS: Design of Cotter and Knuckle joints, Keys: Types of keys, Design of keys, Couplings: Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling.

POWER SCREWS: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, Design of Power Screw, Design of Screw Jack: (Complete Design).

UNIT – V **10 Hours.**

CLUTCHES & BRAKES: Design of Clutches: Single plate, multi plate and cone clutches. Design of Brakes:Block and Band brakes: Self locking of brakes: Heat generation in Brakes.

LUBRICATION AND BEARINGS: Lubricants and their properties, Mechanisms of Lubrication bearing modulus, coefficient of friction, minimum oil film thickness, Heat Generated, Heat dissipated, Bearing Materials, Examples of journal bearing and thrust bearing design.

Essential Readings:

1. Richard Budynas and Keith Nisbett, "Shigley 's Mechanical Engineering Design", 10th edition, McGraw Hill, 2016.
2. V. B Bhandari, "Design of Machine Elements", 4th edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2016.

REFERENCE BOOKS

1. Robert L. Norton, "Machine Design", Pearson Education Asia, 2008.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, "Design of Machine Elements", Pearson Education, 2006.
3. Allen Hall, Alfred Holowenko, Herman Laughlin, "Machine Design", Special edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.
4. Andrew D DIMAROGONAS, "Machine Design, A CAD Approach", John Wiley Sons, Inc, 2001.

Design Data Hand Books:

1. K. Lingaiah, "Machine Design Data Handbook", 2nd edition, McGraw Hill, 2010.
2. K. Mahadevan and Balaveera Reddy, "Design Data Handbook", 4th edition, CBS Publication, 2013.
3. S C Pilli H.G. Patil, "Machine Design Data Handbook", 2nd Edition, I K International Publishing Company Ltd NewDelhi, 2014.

HEAT AND MASS TRANSFER

Sub Code: ME632	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

Course Description: From the study of thermodynamics, students would have learned that energy can be transferred by the interaction of a system with its surroundings. The objective of this course is to extend thermodynamic analysis through study of the modes of heat transfer and through development of mathematical relations, calculate heat transfer rates.

Course Objectives:

- To make students familiar with fundamental heat transfer concepts: conservation of energy, mechanisms of energy conversion, and mechanisms of heat transfer (conduction, radiation, and convection)
- To teach balance of energy applied to integral- and differential-volumes and discuss finite-small volume applied in numerical analysis
- To teach the physics of thermal conduction in fluids and in solids (metals, plastics, ceramics) and composites such as insulation and define thermal conduction resistance
- To teach the physics of thermal radiation and thermal surface properties, and define surface-grayness and view-factor resistance
- To show how is transferred by surface convection, between a moving fluid and a solid, and define surface convection resistance
- To show how thermal circuit analysis can be used for thermal systems
- To enable students to make analysis of practical problems using these concepts and solvers
- To teach the relation of thermal systems analysis to environmental concerns

Prerequisites: Advanced Thermodynamics ME432.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Express the basic concepts of modes of heat transfer, governing laws and boundary conditions of thermal systems using first principle of mathematics
CO2: To describe transient conduction in slab, long cylinder and sphere using Heisler's chart
CO3: Develop correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres using dimensional analysis
CO4: Develop correlations of forced convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres using dimensional analysis
CO5: Express the basic concepts of radiation, governing laws of thermal systems using first principle of mathematics

UNIT -I **10 Hour**
INTRODUCTORY CONCEPTS AND DEFINITIONS: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity;

convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanism. Boundary conditions of 1st, 2nd and 3rd kind.

CONDUCTION: Derivation of general three dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation). One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane and composite walls.Thermal resistance concept and its importance. Overall heat transfer coefficient. Thermal contact resistance.

UNIT – II **10 Hours**

VARIABLE THERMAL CONDUCTIVITY: Derivation for heat flow and temperature distribution in plane wall. Critical thickness of insulation without heat generation. Heat transfer in extended surfaces of uniform cross-section without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and effectiveness. Numerical problems.

ON DIMENSIONAL TRANSIENT CONDUCTION: Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Numerical Problems.

UNIT – III **10 Hours**

CONCEPTS AND BASIC RELATIONS IN BOUNDARY LAYERS: Flow over a body velocity boundary layer; critical Reynolds number; general expressions for drag coefficient and drag force; thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer coefficient; Nusselt number. Flow inside aduct- velocity boundary layer, hydrodynamic entrance length and hydro dynamically developed flow; flow through tubes (internal flow discussion only). Numericals based on empirical relation given in data handbook.

FREE OR NATURAL CONVECTION: Application of dimensional analysis for free convection- physical significance of Grashoff number; use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical problems.

UNIT – IV **10 Hours**

FORCE CONVECTIONS: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various

correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems.

HEAT EXCHANGERS: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems.

UNIT – V **10 Hours**

RADIATION HEAT TRANSFER: Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surfaces.

Radiation heat exchange between two parallel infinite gray surfaces; effect of radiation shield; intensity ofradiation and solid angle; Lambert's law; radiation heat exchange between two finite

surfaces-configuration factor or view factor. Numerical problems.

LAB COMPONENT: **30 Hours**

PART - A

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Determination of Effectiveness on a Metallic fin.
4. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
6. Determination of Emissivity of a Surface.

PART - B

1. Determination of Stefan Boltzman Constant.
2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers
3. Experiments on Boiling of Liquid and Condensation of Vapour
4. Performance Test on a Vapour Compression Refrigeration.
5. Performance Test on a Vapour Compression Air - Conditioner
6. Experiment on Transient Conduction Heat Transfer

TEXT BOOKS:

1. Tirumaleshwar, "Fundamental of Heat and Mass transfer", Pearson Publications, New Delhi, 2012.

2. Ozisik, "Heat transfer - A basic Approach", Tata McGraw Hill, 1984.

REFERENCE BOOKS

1. Yunus A Cengel, "Heat and Mass Transfer, A Practical Approach", Tata McGraw Hill, 2006.
2. Frank Kreith, "Principles of Heat Transfer", 7th edition, Cengage Learning, 2009.
3. Frank P. Incropera and David P, Dewitt, Theodorel Bergman, "Principles of Heat and Mass Transfer" 7th edition, Wiley India, 2014.
4. P.K. Nag, "Heat and Mass transfer", 3rd edition, Tata McGraw Hill Education, 2011.

FINITE ELEMENT METHODS

Sub Code: ME633	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:2	Exam Hours : 03

Course Description: finite element method (FEM) is a numerical technique for finding approximate solutions to boundary value problems for partial differential equations. It uses subdivision of a whole problem domain into simpler parts, called finite elements, and variational methods from the calculus of variations to solve the problem by minimizing an associated error function. Analogous to the idea that connecting many tiny straight lines can approximate a larger circle, FEM encompasses methods for connecting many simple element equations over many small subdomains, named finite elements, to approximate a more complex equation over a larger domain.

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 isoparametric transformation.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Comprehend the concept of FEM in Engineering Applications
CO2: Determine the deflection/deformation of beam & bar by using RR method & Galeriken method
CO3: Determine the stress developed in bar by using elimination and penalty method
CO4: Determine the deformation &stresses in trusses by using elimination method
CO5: Determining the temperature distribution of a thin film by using conduction & convection principle

UNIT-I **10 Hours**

INTRODUCTION: 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.

UNIT-II **10 Hours**

BASIC PROCEDURE: 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.

UNIT-III **10 Hours**

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.

UNIT-IV **10 Hours**

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.

UNIT-V **09 Hours**

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.

LAB COMPONENT: **30 Hours**

PART - A

Study of a FEA package and modeling stress analysis of

1. Bars of constant cross section area, tapered cross section area and stepped bar

2. Trusses – (Minimum 2 exercises)
3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises)

PART - B

4. Stress analysis of a rectangular plate with a circular hole
5. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises)
6. Dynamic Analysis
   c) Fixed – fixed beam for natural frequency determination
   d) Bar subjected to forcing function
   e) Fixed – fixed beam subjected to forcing function

TEXT BOOKS

1. T.R.Chandrupatla, A.D Belegund, "Introduction to Finite Elements in Engineering", 3rd edition, PHI, 2002.

2. S.S. Rao, "Finite Element Method in Engineering", 5th Edition, Elsevier, 2011.

REFERENCE BOOKS

1. U.S. Dixit, "Finite Element Methods for Engineers", Cengage Learning, 2009.

2. R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, "Concepts and applications of Finite Element Analysis", 4th edition, Wiley, 2009.

3. Daryl. L. Logon, "First Course in Finite Element Methods", 5th edition, Cengage Learning, 2012.

4. J.N.Reddy, "An Introduction to the Finite Element Method", 3rd Edition, McGraw -Hill Pulication, 2006.

MECHATRONICS & MICROPROCESSOR

Sub Code: ME634	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Design of processor-controlled electro-mechanical systems. Topics covered include: basic circuits and electronics, mircocontrollers, processor interfacing, timing and control software structures, sensors and actuators, feedback control, and system integration

Course Objectives:

- Implement Mechatronic solutions to a given specification.
- Produce software solutions for a modern microprocessor-based Mechatronic system.
- Understanding various logics and application of the logic to write the programme.
- Knowledge of different types of motors and working principle of it.
- Apply knowledge of control, sensors and actuators to control a Mechatronic system.
- Demonstrate the competence in developing advanced microprocessor-based Mechatronic products.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Manipulate the operation of light sensors & proximity sensors

CO2: Detect the OP-amp data and to discriminate the AC and DC operations

CO3: Design the logic gates

CO4: Design a PLC circuit

CO5: Combine System elements to form a PLC circuit

UNIT – I **10 Hours**

INTRODUCTION TO MECHATRONIC SYSTEMS: Measurement and control systems Their elements and functions, Microprocessor based controllers.

REVIEW OF TRANSDUCERS AND SENSORS: Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.

UNIT-II **10 Hours**

ELECTRICAL ACTUATION SYSTEMS: Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits. **SIGNAL CONDITIONING:** Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signals Multiplexers, Data acquisition, Introduction to Digital system. Processing Pulse-modulation.

UNIT – III **09 Hours**

INTRODUCTION TO DIGITAL SYSTEMS AND 8051 ARCHITECTURE: Evolution of Introduction to logic gates, digital system design and applications, Evolution of Microprocessor and microcontrollers, 8051 Microcontroller: Architecture – Program memory organization – Data memory organization- Internal RAM-SFR-Flag Register-Timers/Counters & its operation registers –Interrupts of 8051 - I/O ports and its structures Interfacing I/O Devices – External memory interfacing-8051 addressing modes.

UNIT – IV **09 Hours**

8051 PROGRAMMING: Instruction set –Data Transfer Instructions - Arithmetic Instructions – Logical Instructions –Control transfer-Bit Manipulation Instructions – Timer/ Counter Programming – Serial Communication Programming- Interrupt Programming & its structure – I/O port Programming Assembly language programming, Introduction to Higher level language programming.

UNIT – V **09 Hours**

SYSTEM DESIGN USING 8051:

EmbeddedC Programming: I/O interfacing, Timers and counters, interrupts;

Interfacing with 8051: LCD Display – Matrix Keypad– ADC–DAC –Sensor – relays – Stepper Motor Control – DC Motor Design and Integrate of a prototype or system.

TEXT BOOKS

1. W.Bolton, "Mechatronics", 4thEd, Pearson Publications, 2011.
2. R.S. Ganokar, "Microprocessor Architecture, Programming And Applications With 8085/8085A", 6th Edition, Penram International Publication, 2013.

REFERENCE BOOKS

1. K.P.Ramchandran, G.K.Vijayraghavan, M.S.Balasundran, "Mechatronics and Microprocessors", 1st edition, Wiley, 2009.
2. Nitaigour and Premchand Mahilik, "Mechatronics - Principles, Concepts and applications" Tata McGraw Hill, 2010.
3. Godfrey C. Onwubolu, "Mechatronics Principles & applications", Elsevier, 2005.
4. David.G. Aliciatore & Michael. B. Histaned, "Introduction Mechatronics & Measurement systems", 4th Edition, Tata McGraw Hill, 2014.

HYDRAULICS AND PNEUMATICS CONTROL

Sub Code: ME635	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

Course Description: This course provides the student with a comprehensive grounding in the basic principles; construction and operation of hydraulic and pneumatic equipment as used in shipboard applications such as controllable pitch propellers, mooring winches, start air systems, etc.

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.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: Understand the operating principle, performance and selection procedure of hydraulic elements and machines
CO2: Understand the working principle of actuators and evaluate actuator performance and justify selection of actuators for various applications
CO3: Identify different types of control valves and understand their working principle and application.
CO4: Design and analyze hydraulic circuits

UNIT -I **10 Hours**

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: PumpsClassification 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).

UNIT-II **10 Hours**

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.

UNIT - III **10 Hours**

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.

UNIT-IV **09 Hours**

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.

UNIT- V **09 Hours**

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).

ELECTRO- PNEUMATIC CONTROL: Principles - signal input and out put, 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.

ESSENTIAL READINGS:

1. Anthony Esposito, "Fluid Power with Applications", 7TH edition, Pearson Education, Inc, 2014.
2. Andrew Parr, "Pneumatics and Hydraulics", Jaico Publilishing Co, 2005.

REFERENCE BOOKS

1. S. R. Majumdar, "Oil Hydraulic systems Principles and Maintenance", Tata Mc Graw Hill Publishing Company Ltd., 2001.
2. Pippenger, Hicks, "Industrial Hydraulics", McGraw Hill, New York.
3. Harry L. Stewart, "Hydraulic & Pneumatic Power for Production",.
4. S. R. Majumdar, "Pneumatic Systems", Tata Mc Graw Hill Publishers, 1995.
5. Michael J Pinches & John G Ashby, "Power Hydraulics", Prentice Hall.
6. Jagadeesha T ,Hydraulics and Pneumatics ", , I K International Publishing House,Private Ltd.
7. R Srinivasan ,"Hydraulic and Pneumatic Control ",2nd Edition, Tata Mc Graw Hill Publication

LAB COMPONENT **30 Hours**

Objectives

To understand the requirements of industrial automation

To learn different universal symbols used in pneumatics and hydraulics

To estimate the technical requirement to automate a process

To design a circuit to automate industrial process based on pneumatics and hydraulics

Course Outcomes

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

1. To differentiate pneumatic and hydraulic requirement
2. To design a conceptual diagram for the industry automation
3. To calculate the required air and liquid pressure for the process based on its nature
4. To debug the process at its failure and recover to normal working state.

List of Experiments

1. Introduction to Pneumatic and Hydraulic symbols
2. To Control of a Casting Ladle movement using one-way flow control valve
3. To Feed a pin continuously using limit switches
4. To use a pneumatic timer in welding of plastic sheet
5. To determine the pressure for stamping a badge with uniform press using double acting cylinders
6. To control a furnace door using manual operated hydraulic valve
7. To control a surface Grinding machine
8. To determine the hydraulic pressure for a Drilling machine
9. To use hydraulic motor and accumulator for an Earth Drill used in construction site
10. To utilize the pressure sequence valve to handle a garbage box used in solid waste management.
11. Using directional control flow valves for distributing Billiard Balls
12. To feed a paper roll for the next stage of process

SEMESTER VII

ENGINEERING ECONOMICS

Sub Code: ME731	**L:T:P**	**Total Lecture Hrs :47**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course covers the fundamentals of engineering economics and basic accounting. It will help students understand how an organization can utilize its capital economically when it makes capital decisions.

Course Objectives:

- Prepare engineering students to analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.
- Be able to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.
- Be able to perform and evaluate payback period and capitalized cost on one or more economic alternatives.
- Be able to carry out and evaluate benefit/cost, life cycle and break even analyses on one or more economic alternatives.

Level of Learning: Basic.

Learning Outcomes:

Upon completion of this course, the students will be able to
CO1: Understand the methods of problem solving and decision making
CO2: Project comparisons based on time value of money
CO3: Concepts of inflation and cost calculation
CO4: Apply the concept of ratio analysis and budget
CO5: Discuss the application of economics in product development

UNIT-I 10 Hours

INTRODUCTION: Engineering Decision Makers, Engineering and Economics – Fundamental Concepts, National Income Concepts – GDP, Per Capita Income, Problem Solving and Decision Making, Intuition and Analysis, Interest and Interest Factors, Interest Rate, Simple Interest, Compound Interest, Cash Flow Diagrams, EMI calculation, Taxes and GST, Numericals

PRESENT-WORTH COMPARISONS: Conditions for Present Worth comparisons, Basic present worth comparisons, Assets with equal and unequal lives, Infinite lives, Future worth Comparisons, Pay Back Comparison.

UNIT-II 10 Hours

EQUIVALENT ANNUAL WORTH COMPARISONS: Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparisons, Consideration of Asset Life, Comparison of Assets with Equal and Unequal Lives, Use of Sinking Fund Method.

RATE-OF-RETURN CALCULATIONS AND DEPRECIATION: Rate of Return, Minimum Acceptable Rate of Return, IRR, IRR Misconceptions, Cost of Capital Concepts, Causes of Depreciation,

UNIT-III 09 Hours

INFLATION: Causes of Inflation, Measures to Control Inflation, Effects of Inflation, Comparison between inflation and deflation.

COSTING: Components of Cost, Direct Material Cost, Direct Labour Cost, Fixed Over-Heads Cost, Factory Costs, Administrative Over-Heads, First Cost, Marginal Cost, Selling Price and Estimation for simple components. Balance Sheet, Simple Problems.

UNIT-IV 09 Hours

FINANCIAL RATIO ANALYSIS: Introduction, Nature of Ratio Analysis, Liquidity Ratios, Leverage Ratios, Activity Ratios, Profitability Ratios, Evaluation of a Firm's Earning Power, Comparative Statements Analysis.

FINANCIAL AND PROFIT PLANNING: Introduction, Financial Planning, Profit Planning, Objectives of Profit Planning, Essentials of Profit Planning, Budget Administration, Types of Budgets.

UNIT-V 09 Hours

PRODUCT DEVELOPMENT ECONOMICS: Early design – Requirement Definition and Conceptual design - Trade-off Analysis – Optimization using cost and utility metrics – Trade-off analysis models and parameters Elements of economic analysis, base case financial mode,. Sensitivity analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis

ESSENTIAL READINGS:

1. Riggs J.L., "Engineering Economy", 4th edition, McGraw Hill, 2004
2. Thuesen H.G., "Engineering Economy",9th edition PHI , 2002
3. A C Chitale and R C Gupta., "Product Design and Manufacturing", 3rd Edition, PHI, 2003
4. John W. Priest and Jose M. Sanchez, " Product development and design for manufacturing- A collaborative approach to produciability and reliability", Marcel Dekker Publications, 2001

REFERENCE BOOKS

1. IM PANDEY, "Finacial Management", Vikas Publisahing House, 2002
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers
3. Tarachand, "Engineering Economy",Nem Chand & Brothers , 2000
4. Prasanna Chandra, "Financial Mangement", TMH, 2004

MECHANICAL VIBRATIONS

Sub Code: ME732	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

CourseDescription: General theory of free, forced, and transient vibrations; vibration transmission, isolation, and measurement; normal modes and generalized coordinates; method of matrix equation formulation and solution. The application of theory and methods to the analysis, measurement and design of dynamic systems.

Course Objective:

- To be able to obtain linear vibratory models of dynamic systems with changing complexities (SDOF, MDOF)
- To be able to write the differential equation of motion of vibratory systems,
- To be able to make free and forced (harmonic, periodic, non-periodic) vibration analysis of single and multi-degree of freedom linear systems.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Mathematical modelling of vibratory systems
CO2: Solve differential equations for free vibration of single degree freedom systems
CO3: Solve differential equations for forced vibration of single degree freedom systems
CO4: Design mechanical systems to achieve vibration isolation and measurement of vibration
CO5: Formulate mathematical equations for free & forced vibration of two degree and Multi degree of freedom systems
CO6: Apply the governing equations to continuous systems

UNIT - I **10 Hours**

INTRODUCTION: Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of super position applied to SHM, Beats, Fourier theorem and problems.

UNDAMPED (SINGLE DEGREE OF FREEDOM) FREE VIBRATIONS: Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and Problems.

UNIT - II **10 Hours**

DAMPED FREE VIBRATIONS (1DOF): Types of damping**,** Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and

Problems. **FORCED VIBRATIONS (1DOF):** Introduction, Analysisofforced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping and Problems.

UNIT -III **10 Hours**

VIBRATION MEASURING INSTRUMENTS AND WHIRLING OF SHAFTS: Seismic INSTRUMENTS – Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.Modal analysis and Condition Monitoring

SYSTEMS WITH TWO DEGREES OF FREEDOM: Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, geared systems and Problems. Undamped dynamic vibration absorber and Problems.

UNIT – IV **10 Hours**

NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS: Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, Holzer's method, Orthogonality of principal modes, method of matrix iteration and Problems.

UNIT-V **10 Hours**

CONTINUOUS SYSTEMS: Vibrating string, Longitudinal vibration of rods, Torsional vibration of rods, Suspension bridge as continuous system, Euler equation for beams, Vibration of membranes.

TEXT BOOKS

1. S. S. Rao, "Mechanical Vibrations", 5th edition, Pearson Education Inc, , 2010.
2. V. P. Singh, "Mechanical Vibrations", 3rd edition, Dhanpat Rai & Company, 2014 (reprint).

REFERENCE BOOKS

1. W. T. Thomson, M. D. Dahleh and C. Padmanabhan, "Theory of Vibration with Applications", 5th edition, Pearson Education Inc, , 2008.
2. Schaum's outline Series, "Mechanical Vibrations: S. Graham Kelly", Special Indian Edition ,Tata McGraw Hill, , 2007.
3. J. S. Rao & K. Gupta, "Theory and Practice of Mechanical Vibrations", 2nd edition, New Age International Publications, New Delhi, 2014 (reprint).
4. G. K.Grover, "Mechanical Vibrations", 8th edition, Nem Chand and Bros, 2009.

OPERATIONS RESEARCH

Sub Code: ME733	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description:

- Operations research helps in solving problems in different environments that needs decisions.
- The module covers topics that include: linear programming, Transportation, Assignment, and CPM/ MSPT techniques. Analytic techniques and computer packages will be used to solve problems facing business managers in decision environments.

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.

Course Outcomes:

Upon completion of the subject, students will be able to
CO1: To compute and solve the linear programming method by Simplex and Big M method.
CO2: To Calculate the transportation parameters by MODI method
CO3: To determine the critical path by using CPM and PERT method.
CO4: To detect the empirical values of queuing systems.
CO5: To arrange the jobs in multiple machines.

UNIT -I **10 Hours**

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.

SOLUTION OF Linear Programming PROBLEMS: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables, big M method and concept of duality, dual simplex method

UNIT -II **10 Hours**

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.

UNIT -III **10 Hours**

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.

UNIT-IV **10 Hours**

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.

UNIT -V **10 Hours**

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.

ESSENTIAL READINGS:

1. P K Gupta and D S Hira, "Operations Research", 6th edition, Chand Publications, New Delhi , 2014.
2. Taha H A, "Operations Research", 10th edition, Pearson Education, 2016.
3. El-Ghazali Talbi, "Metaheuristics: From Design to Implementation", 2013 Edition, Wiley Publishers, ISBN-13: 978-0470278581
4. Kalavathy.S, "Operation research", 4th Edition, Vikas Publishing House, 2013, ISBN:978-93-259-6347-4

REFERENCE BOOKS

1. A P Verma, "Operations Research", 7th edition, S K Kataria &Sons, , 2016(reprint)
2. Paneerselvam, "Operations Research", 2nd edition, PHI, 2006.
3. A M Natarajan and P Balasubramani, "Operations Research", 4th impression, Pearson Education, 2009.
4. Hiller and Liberman, "Introduction to Operations Research", 9th edition, McGraw Hill, 2012.
5. S.D. Sharma, "Operations Research", Ledarnath Ramanath & Co, 2002.
6. Mitsuo Gen & Runwei Cheng, "Genetic Algorithm and engineering Design", 1997 Edition, A Wiley- Interscience Publication, ISBN:0-471-12741-8

MECHATRONICS & MICROPROCESSOR

Sub Code: ME734	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Design of processor-controlled electro-mechanical systems. Topics covered include: basic circuits and electronics, mircocontrollers, processor interfacing, timing and control software structures, sensors and actuators, feedback control, and system integration

Course Objectives:

- Implement Mechatronic solutions to a given specification.
- Produce software solutions for a modern microprocessor-based Mechatronic system.
- Understanding various logics and application of the logic to write the programme.
- Knowledge of different types of motors and working principle of it.
- Apply knowledge of control, sensors and actuators to control a Mechatronic system.
- Demonstrate the competence in developing advanced microprocessor-based Mechatronic products.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Manipulate the operation of light sensors & proximity sensors
CO2: Detect the OP-amp data and to discriminate the AC and DC operations
CO3: Design the logic gates
CO4: Design a PLC circuit
CO5: Combine System elements to form a PLC circuit

UNIT – I **10 Hours**

INTRODUCTION TO MECHATRONIC SYSTEMS: Measurement and control systems Their elements and functions, Microprocessor based controllers.

REVIEW OF TRANSDUCERS AND SENSORS: Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.

UNIT-II **10 Hours**

ELECTRICAL ACTUATION SYSTEMS: Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits. **SIGNAL CONDITIONING:** Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signals Multiplexers, Data acquisition, Introduction to Digital system. Processing Pulse-modulation.

UNIT – III **09 Hours**

INTRODUCTION TO DIGITAL SYSTEMS AND 8051 ARCHITECTURE: Evolution of Introduction to logic gates, digital system design and applications, Evolution of Microprocessor and microcontrollers, 8051 Microcontroller: Architecture – Program memory organization – Data memory organization- Internal RAM-SFR-Flag Register-Timers/Counters & its operation registers –Interrupts of 8051 - I/O ports and its structures Interfacing I/O Devices – External memory interfacing-8051 addressing modes.

UNIT – IV **09 Hours**

8051 PROGRAMMING: Instruction set –Data Transfer Instructions - Arithmetic Instructions – Logical Instructions –Control transfer-Bit Manipulation Instructions – Timer/ Counter Programming – Serial Communication Programming- Interrupt Programming & its structure – I/O port Programming Assembly language programming, Introduction to Higher level language programming.

UNIT – V **09 Hours**

SYSTEM DESIGN USING 8051:

EmbeddedC Programming: I/O interfacing, Timers and counters, interrupts;

Interfacing with 8051: LCD Display – Matrix Keypad– ADC–DAC –Sensor – relays – Stepper Motor Control – DC Motor Design and Integrate of a prototype or system.

TEXT BOOKS

3. W.Bolton, "Mechatronics", 4thEd, Pearson Publications, 2011.
4. R.S. Ganokar, "Microprocessor Architecture, Programming And Applications With 8085/8085A", 6th Edition, Penram International Publication, 2013.

REFERENCE BOOKS

5. K.P.Ramchandran, G.K.Vijayraghavan, M.S.Balasundran, "Mechatronics and Microprocessors", 1st edition, Wiley, 2009.
6. Nitaigour and Premchand Mahilik, "Mechatronics - Principles, Concepts and applications" Tata McGraw Hill, 2010.
7. Godfrey C. Onwubolu, "Mechatronics Principles & applications", Elsevier,2005.
8. David.G. Aliciatore & Michael. B. Histaned, "Introduction Mechatronics & Measurement systems",4th Edition, Tata McGraw Hill, 2014.

DESIGN LABORATORY

Sub Code: ME751	L:T:P	Total Lecture Hrs :30
Exam Marks: 50	Hrs/week : 0:0:2	Exam Hours : 03

Course Description: Provides working knowledge of design Engineering.

Coure Objective:

- To develop skills in the field of design Engineering.
- Verify the principles of the course, Application of the theory, Understanding of fundamentals of the subject design Engineering.
- Be in a position to relate theory and practice,

Level of knowledge: Working.

Learning Outcomes:

- Will be able to apply the concepts of design Engineering, appreciate its application in various engineering application.
- Will be able to perform design engineering experiments for various mechanical elements.
- To develop scientific, technical and experimental skills to the students.
- To correlate the theoretical principles with application based studies.

PART - A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft.
4. Determination of Fringe constant of Photoelastic material using.
    a. Circular disc subjected to diametral compression.
    b. Pure bending specimen (four point bending)
5. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook.

PART - B

6. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Prowel /Hartnel Governor. (only one or more)
7. Determination of Pressure distribution in Journal bearing.
8. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
9. Determination of stresses in Curved beam using strain gauge.
10. Experiments on Gyroscope (Demonstration only)

HEAT & MASS TRANSFER LABORATORY

Sub Code: ME752	**L:T:P**	**Total Lecture Hrs :30**
Exam Marks: 50	**Hrs/week : 0:0:2**	**Exam Hours : 03**

Course Description: Provides working knowledge of heat & mass transferengineering.

Course Objectives:

- To develop skills in the field of heat & mass transferengineering.
- Verify the principles of the course,Application of the theory , Understanding of fundamentals of the subject.
- Be in a position to relate theory and practice,

Level of knowledge: Working.

Learning Outcomes:

- Will be able to apply the concepts of heat & mass transferengineering, appreciate its application in various engineering application.
- Will be able to perform various test of heat & mass transferengineering for various mechanical properties.
- Will be able to carry out performance tests on heat & mass transferengineering.
- To develop scientific, technical and experimental skills to the students.
- To correlate the theoretical principles with application based studies.

PART - A

6. Determination of Thermal Conductivity of a Metal Rod.
7. Determination of Overall Heat Transfer Coefficient of a Composite wall.
8. Determination of Effectiveness on a Metallic fin.
9. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
10. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
11. Determination of Emissivity of a Surface.

PART - B

7. Determination of Stefan Boltzman Constant.
8. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers
9. Experiments on Boiling of Liquid and Condensation of Vapour
10. Performance Test on a Vapour Compression Refrigeration.
11. Performance Test on a Vapour Compression Air - Conditioner
12. Experiment on Transient Conduction Heat Transfer

SIMULATION LAB

Sub Code: ME753	L:T:P	Total Lecture Hrs :30
Exam Marks: 50	Hrs/week : 0:0:2	Exam Hours : 03

This course is focused on learning programming by using MATLAB to solve mathematical problems. It is divided into two part2.

Part A

1. **Introduction to MATLAB: (2 Hours)**

   We will learn how to start MATLAB and will familiarize ourselves with its user interface. We will learn how to use MATLAB as a sophisticated calculator. We will learn about syntax and semantics.

2. **Plotting In MATLAB: (2 Hours)**

   We introduce Matlab technique to draw the graph of functions in a variety of formats. We will begin our work in the plane, plotting the graphs of function, then moving to graphs defined by parametric and polar equations. We will then move to 3-space and investigate the nature of curves and surfaces in space.

3. **Matrices and Operations: (2 Hours)**

   We will learn how to define matrices and vectors, extract parts of them and combine them to form new matrices. We will learn how to use operators to add, subtract, multiply and divide matrices and we will learn that there are several different types of multiplication and division.

4. **Functions: (2 Hours)**

   In this section we will learn how to break the complex problem into smaller, more manageable parts. We will learn how functions let us create reusable software components that can be applied in many different programs. We will learn how the environment inside a function is separated from outside via a well defined interface through which it communicates with outside world. We will learn how to define a function to allow input to it when it initiates its execution and output from it when it is done.

5. **Loops: (2 Hours)**

   Loops give computer their power. We will learn how to use both of MATLAB's loop construct: the for-loop, if-loop and the while-loop. We will learn how the break statement works and we will use nested loops.

Part B

6. **Mechanical Vibrations and Finite element analysis: (2 Hours)**

   Introduction of the mechanical vibrations and few concepts related to it will be discussed. Further, we will learn how to solve mechanical vibration problems using MATLAB. It will cover solving mechanical vibration problems related single, double and three degree of freedom.

<u>Scheme of Examination:</u>

One Question Part-A	:	15 marks
One Question Part-B	:	25 marks
Viva	:	10 marks
Total	:	50marks

SERVICE LEARNING

Sub Code: ME771	L:T:P	Total Lecture Hrs :30
Exam Marks: 50	Hrs/week : 1:0:2	Exam Hours :

Course Objective:

After completing the course, the students will be expected to have:

- Awareness of their role as human beings and engineers on Earth;
- Understanding of natural systems and how human-made structures adapt and adjust to natural systems and vice-versa;
- An understanding of the role of system engineering in design of human activity systems;
- New skills and tools for finding common themes, developing connections, asking critical questions, providing more holistic answers, and for integrating economic,social, and environmental aspects into decision making

Course Outcomes:

Upon completion of the subject, students will be able to;

CO1: Develop a habit of critical reflection for life-long learning in solving societal problems;
CO2: Will be able to apply knowledge of pollutants & waste products in human settlements using safe processes and engineering practices reinforcing their ethical , social and civic responsibility;
CO3: Apply the knowledge from the experience gained, in finding alternative solutions to improve the habitat
CO4: Learn how to work more collaboratively with others on finding solutions for societal needs;
CO5: Will be able to adopt to other cultures and respect cultural differences due to experiential learning;
CO6: Can comprehend the impact of engineering decisions on settlements and find solutions to mitigate the adverse causes.

MODULE – I Solid waste Management (Theory –6; Field Work -24)

SOURCES OF SOLID WASTES: Types and Sources of solid wastes. Need for solid waste management. Elements of integrated waste management and roles of stakeholders. Salient features of Indian legislations on management and handling of municipal solid wastes, plastics and fly ash.

COLLECTION & SEGREGATION: Handling and segregation of wastes at source. Storage and collection of municipal solid wastes. Analysis of Collection systems. Need for transfer

and transport. Transfer stations Optimizing waste allocation. Compatibility, storage, labeling wastes.

Field Work:

Design and fabrication of portable Road dust cleaner.

OR

MODULE– II Managing stagnant Ponds (Theory –6; Field Work -24)

PURIFICATION OF STAGNANT PONDS : Introduction to Microbiology : Microbial ecology and Growth kinetics; Types ofmicroorganisms; aerobic vs. anaerobic processes
Biological Unit Processes :Aerobic treatment; Suspended growth aerobic treatment processes; Activated sludge process and its modifications; Attached growth aerobic processes; Trickingfilters and Rotating biological contactors; Anaerobic treatment; suspended growth, attached growth,fluidized bed and sludge blanket systems; nitrification, denitrification; Phosphorus removal
Sludge Treatment: Thickening; Digestion; Dewatering; Sludge drying; Composting
Natural Wastewater Treatment Systems:Ponds systems.

OR

MODULE – III Solar power (Theory – 6; Field Work - 24)

SOLAR ENERGY: Global and National scenarios, Form and characteristics of renewable energy sources, Solar radiation, its measurements and prediction, Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems

SOLAR PHOTOVOLTAIC: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes, Basic concepts of Solar power, Solar cells. Applications of Solar-in Hospitals, automobiles, Air cooling, water cooling, Domestic Power generation, Industrial power generation, Traffic signals, Electronic equipments, refrigeration**.**

OR

MODULE – IV Atmospheric pollution (Theory –6; Field Work -24)

MANAGING ATMOSPHERIC POLLUTION Introduction to Atmospheric pollution-sources and causes. Methods of reducing pollution from vehicles, industries, domestic, urban and rural sources. Devising innovative pollution control devices& methods -filters, bags, traps, seperators,

REFERENCE BOOKS

1. S. P. Sukhatme, "Solar Energy, Principles of Thermal Collection and Storage," 6th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1990
2. George Techobanoglous et al, "Integrated Solid Waste Management" McGraw - Hill, 1993.
3. George Techobanoglous, Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.
4. R.E.Landrefh and P.A.Rebers," Municipal Solid Wastes-Problems & Solutions", Lewis, 1997.

5. Manual on Municipal Solid waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi, 2000.
6. Blide A.D. & Sundaresan, B.B,"Solid Waste Management in Developing Countries", INSDOC, 1993
7. Michael Allaby, "Fog, Smog and poisoned rain", Facts on File Inc, ISBN:0-8160-4789-8
8. *Arceivala* S. J. and Asolekar S. R. (2006). *Wastewater Treatment for Pollution Control and Reuse*. 3rd edn, *Tata McGraw Hill*, New Delhi, 2015
9. Wastewater Engineering (Environmental Engineering-II), (Including Air Pollution) Arun Kumar Jain,Ashok Kumar Jain,B.C. Punmia, Laxmi Publications Pvt. Ltd (2014) ISBN 10: 8131805964 ISBN 13: 9788131805961

Purpose of the course:

To apply mechanical engineering concepts for the benefit of society. The technical basis could be from any engineering disciple course. The topic suggestions above are only indicative.

Milestones for conduct of Course.

SNO	DURATION	TASK ASSIGNED	COURSE TEACHER /PANEL MEMBERS SIGNATURE
1.	5th Week	Problem identification	
2.	6th Week	Concept Solution	
3.	7th Week	Field visit relevant to your topic	
4.	8th week	Design and Material procurement	
5.	9th Week	Completing the assembly and testing	
6.	10th Week onwards	Presentation before the panel members.	

EVALUATION: (50 MARKS) Student's final grade will be determined as follows:

a) CIA 1 - homework assignments = 20%
b) MSE - mid term review = 30 %
c) CIA 3 – Interim Review = 20 % (Term paper – fit to be published in Proceedings/Journal)
d) ESE – Final review = 30% (Project Report + Presentation to an Evaluation Board)
e) There will be no separate examination.

TERM PROJECT: The project should address a topic of student's choice that involves natural systems and the interaction of the built environment (infrastructure) with natural systems. The project must emphasize the role of technical and non-technical (economic,

social, ecological, ethical, philosophical, political, psychological, cultural) issues in shaping the engineering decisions.
The project should provide an in-depth analysis of an application correlating the engineering principles discussed in class to the topic that students have selected. Case studies are strongly encouraged.
Students will be made in to group of 10-18 with a faculty in charge. Project will be selected at the discretion of students group and faculty in charge. All projects must be approved by the Faculties in-charge/HoDs/Deanery, upon submission of a one-page summary within 15 days of course commencement.

Project will culminate in a report and a presentation. The report may be about 20 pages (single spaced including figures, references and Bibliography & Appendices/Annexures. Submission should be made atleast 3 weeks before end of semester as per Academic calendar.

INTERNSHIP

Sub Code: ME772	**L:T:P**	**Total Lecture Hrs :**
Exam Marks:	**Hrs/week : 0:0:4**	**Exam Hours :**

Internships are short-term work experiences that will allow a student to observe and participate in professional work environments and explore how his interests relate to possible careers. They are important learning opportunities trough industry exposure and practices. More specifically, doing internships is beneficial because they provide the opportunity to:

- 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

Regulations

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 semesters.

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.

SEMESTER VIII

CONTROL ENGINEERING

Sub Code: ME831	**L:T:P**	**Total Lecture Hrs :50**
Exam Marks: 50	**Hrs/week : 3:1:0**	**Exam Hours : 03**

Course Description:

The course studies dynamic systems encountered in a variety of instrumentation and mechatronic systems. It will look at the modelling of such systems and the response of these systems to a disturbance. In addition, the control of dynamic systems using feedback and the design of control systems using different design techniques will be studied.

Course Objectives:

- To impart the fundamental concepts of Control systems and mathematical modeling of the system
- To study the concept of time response and frequency response of systems
- To teach the basics of stability analysis of the system

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Mathematically model and determine the response of First & Second order systems to applied inputs
CO2: Develop and Analyse block diagrams and signal flow graphs for physical systems
CO3: Understand the concept of the system stability using frequency domain analysis
CO4: Understand the concept of control action and types of controllers
CO5: Analysis of control System using Root Locus and Nyquist plots
CO6: Analysis of control System using Bode plots and learn basics of state space techniques for control systems

UNIT – I **10 Hours**

INTRODUCTION: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.

MATHEMATICAL MODELS: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system, Analogous systems: Force voltage, Force current.

UNIT – II **10 Hours**

BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS: Transfer Functions definition, function, blocks representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula.

TIME RESPONSE ANALYSIS:

Transient and Steady State Response Analysis: Standard test signals, time response of second order systems and their specifications, steady state errors and error constants, Controllers and its applications: P, PI, PD, PID.

UNIT – III **10 Hours**

FREQUENCY RESPONSE ANALYSIS-I : Stability of Control Systems, Introduction; Characteristic Equation; Routh-Hurwitz criteria and its limitations

ROOT LOCUS METHOD : Introduction; Root Ioci of a Second Order System; General Case; Rules for Drawing Forms of Root Ioci; Relation between Root Locus Locations and Transient Response; Parametric Variation; Problems.

UNIT – IV **10 Hours**

FREQUENCY RESPONSE ANALYSIS-II

Frequency Response Analysis UsingPolar plots and Nyquists Criterion, Gain & Phase Margins: Problems.

Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams.

UNIT- V **10 Hours**

SYSTEM COMPENSATION AND STATE VARIABLE CHARACTERISTICS OF LINEAR SYSTEMS:

Series and feedback compensation,

STATE SPACE ANALYSIS OF CONTROL SYSTEMS: Introduction; Introduction to state concepts Generalized State Equation; Techniques for Deriving System State – Space Equations; Transfer Function from State Equations; Solution of State Vector Differential Equations; Discrete Systems

TEXT BOOKS

1. Katsuhiko Ogatta, "Modern Control Engineering", Pearson Education, 2004.
2. M.Gopal, "Control Systems Principles and Design", TMH, 2000.
3. Kuo, "Automatic Control Systems", Prentice Hall of India, New Delhi.

REFERENCE BOOKS

1. Richard.C.Dorf and Robert.H.Bishop, "Modern Control Systems", Addison Wesley, 1999.

2. Eronini-Umez, "System dynamics & control", Thomson Asia pte Ltd. singapore, 2002.

3. Allen J. Stubberud, "Feedback Control System", Second edition, Schaum's series, 2001.

4. B.C. Nakra, "Theory & Applications of Automatic Controls", New Age International Pvt. Ltd. Publishers, New Delhi.

CYBER SECURITY

Sub Code: BTCY01	L:T:P	Total Lecture Hrs : 15
Exam Marks:	Hrs/week : 1:0:0	Exam Hours :

AIM: This course is aimed at providing a comprehensive overview of the different facets of Cyber Security. In addition, the course will detail into specifics of Cyber Security with Cyber Laws both in Global and Indian Legal environments.

Objectives

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

UNIT-I

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.

UNIT-II

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.

UNIT-III

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 - DisasterTypes - Disaster Recovery Plan - Business Continuity Planning Process.

UNIT-IV

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.

UNIT-V

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

REFERENCE BOOKS

1. Matt Bishop, "Introduction to Computer Security", 6th impression. Pearson, 2004.
2. Thomas R, Justin Peltier, John, "Information Security Fundamentals", Auerbach Publications, 2004.
3. AtulKahate, "Cryptography and Network Security", second Edition, Tata McGrawHill, 2001.
4. Nina Godbole, SunitBelapure, "Cyber Security", 1st Edition, Wiley India 2011.
5. Cyber Security Policy Guidebook, , Wiley; 1 edition , 2012,
6. Jennifer L. Bayuk and Jason Healey and Paul Rohmeyer, Dan Shoemaker and Wm. Arthur Conklin and Marcus Sachs, "Cybersecurity: The Essential Body of Knowledge", Delmar Cengage Learning; 1 edition (May 17, 2011).
7. Stallings, "Cryptography & Network Security - Principles & Practice", 6th Edition, Prentice Hall, 2014.

ELECTIVE-I
PROJECT MANAGEMENT

Sub Code: ME532 E1	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: The purpose of this course is to lay the foundation for a solid understanding of project management concepts and principles and to familiarize students with the complexity and challenge of managing public or private projects with tight schedules and limited resources. Students will gain a sound understanding of project management concepts and principles by applying relevant tools and techniques and by making extensive use of case studies and simulation exercises to assimilate that knowledge

Learning Objectives: 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

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Apply the concept of project management in engineering field through project management life cycle
CO2: Analyze the quality management and project activity in engineering field through work breakdown structure.
CO3: Analyze the fundamentals of project and network diagram in engineering and management domain through PDM techniques.
CO4: Evaluate the concept of network analysis through PERT and CPM techniques
CO5: Apply the concept of schedular based on resource avaibability in engineering and management field through project proposal

Prerequisite: Nil

UNIT 1 **09 Hours**

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

UNIT 2 **09 Hours**

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

UNIT 3 **09 Hours**

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, Analyzing the Initial Project Network Diagram.

UNIT 4 **10 Hours**

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 leveling and Resource allocation

Unit 5 **09 Hours**

Schedules Based on Resource Availability: Resources, Leveling Resources, Acceptability Leveled Schedule, Resource Leveling Strategies, Work Packages: Purpose of a Work Package, Format of a Work Package

Joint Project Planning Session: Planning the Sessions, Attendees, Facilities, Equipments, Complete Planning Agenda, Deliverables, Project Proposal

TEXT BOOKS:

1. Robert K. Wysocki, Robert Beck. Jr., and David B. Crane, "Effective Project Management", John Wiley & Sons 2003.
2. Dr. B.C. Punmia & K.K.Khandelwal, "Project Planning and Control with CPM and PERT", Laxmi Publications, 2011.

REFERENCE BOOKS

1. S. Choudhury, "Project Management", TMH Publishing Co. Ltd, 1998.
2. P. K. Joy , "Total Project Management- The Indian Context", Macmillan India Ltd., 2017.
3. Adedeji Bodunde Badiru ,"Project Management in Manufacturing and High Technology Operations", John Wiley and Sons, 2008.
4. R.C.Gupta,"Course in PERT & CPM", DhanpatRai and Sons, New Delhi.
5. S.K. Bhattacharjee, "Fundamentals of PERT/ CPM and Project Management", Khanna Publishers, 2004.

NON-TRADITIONAL MACHINING

Sub Code: ME532E2	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: ThisCourse describes various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The many processes that have this common theme, controlled material removal, are collectively known as subtractive manufacturing, in distinction from processes of controlled material addition.

Course Objectives:

- Introduction of modern machining methods and their difference with conventional machining methods,
- Different classification criteria of modern machining methods and their classifications,
- Working principle, process details, applications, advantages, and disadvantages machining.

Course Outcomes:
Upon completion of the subject, students will be able to
CO1: Classify the mechanism of Non-Traditional machining processes and process parameters and their effect on the component machined in USM
CO2: Summarize the applications of AJM/WJM processes
CO3: Describe the principle of ECM and CHM processes and mechanism of material removal of ECM/CHM
CO4: Differentiate Thermal Metal Removal Processes, characteristics of spark eroded surface, machine tool selection
CO5: Relate the generation and control of Plasma arc, electron beam and laser beam for machining and comparison

UNIT – I **10 Hours**

INTRODUCTION: History, Classification, comparison between conventional and Non-conventional machining process selection.

ULTRASONIC MACHINING (USM): Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design:- Effect of parameter: Effect of amplitude and frequency and vibration, Effect of abrasive grain diameter, effect of applied static load, effect of slurry, tool & work material, USM process characteristics: Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.

UNIT – II **10 HoursABRASIVE JET MACHINING (AJM):** Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean number. abrasive particles per unit volume of the carrier gas, work material, stand off

distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. Water Jet Machining**:** Principal, Equipment, Operation, Application, Advantages and limitations of water Jet machinery

UNIT – III **10 Hours**

ELECTROCHEMICAL MACHINING (ECM): Introduction, study of ECM machine, elements of ECM process : Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Process characteristics – Material removal rate, Accuracy, surface finish, ECM Tooling: ECM tooling technique & example, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug, Economics of ECM, Applications such as Electrochemical turning, Electrochemical Grinding, Electrochemical Honing, deburring, Advantages, Limitations.

CHEMICAL MACHINING (CHM): Introduction, elements of process, chemical blanking process : Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps –masking, Etching, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

UNIT - IV **09 Hours**

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode manufacture, Electrode wear, EDM tool design, choice of machining operation, electrode material selection, under sizing and length of electrode, machining time. Flushing; pressure flushing, suction flushing, side flushing, pulsed flushing synchronized with electrode movement, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, EDM accessories / applications, electrical discharge grinding, Traveling wire EDM.

UNIT – V **09 Hours**

PLASMA ARC MACHINING (PAM): Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.

LASER BEAM MACHINING (LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM.

TEXT BOOKS

1. Pandey and Shah, Modern machining process, 33RD reprint, Tata McGraw Hill, 2008.

2. Bhattacharya, "New Technology", 2000.

REFERENCE BOOKS

1. HMT, "Production Technology", 28th reprint Tata McGraw Hill. 2008.

2. Aditya, "Modern Machining Process", 2002.

3. P.K.Mishra, "Non-Conventional Machining", The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.

4. Joseph R. Davis (Editor), "Metals Handbook: Machining Volume 16", 9th edition American Society of Metals (ASM), 2001.

COMPOSITE MATERIALS

Sub Code: ME532E3	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course deals with the basics of composite materials and the study of various laminar structure and the fabrication of Metal Matrix composites and its analysis.

Course Objectives:

- An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
- An ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.
- An ability to rotate stress, strain and stiffness tensors using ideas from matrix algebra.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Define Composite materials, manufacturing processes, and applications of composite materials.
CO2: Distinguish between different types of composite materials.
CO3: Analyze problems on macro-mechanical behaviour of lamina in FRP Composites.
CO4: Analyze problems on micro-mechanical behaviour of lamina in FRP Composites.
CO5: Identify the physical , mechanical and wear properties of the Metal matrix composites.

UNIT – 1 **10 Hours**

INTRODUCTION TO COMPOSITE MATERIALS: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites.

APPLICATIONS: Automobile, Aircrafts. missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

FIBER REINFORCED PLASTIC PROCESSING: Lay up and curing, fabricating process, open and closed mould process, hand lay uptechniques;structural laminate bag molding, production procedures for bag molding;filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

UNIT – 2 **09Hours**

MICRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Numerical problems. **Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix.

UNIT – 3 **10 Hours**

MACRO MECHANICS OF A LAMINA Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

BIAXIAL STRENGTH THEORIES: Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problems.

UNIT – 4 **10Hours**

MACRO MECHANICAL ANALYSIS OF LAMINATE: Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) ,Special cases of laminates, Numerical problems

METAL MATRIX COMPOSITES: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application. **FABRICATION PROCESS FOR MMC'S:** Powder metallurgy technique,liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT – 5 **09Hours**

STUDY PROPERTIES OF MMC'S: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.

ESSENTIAL READINGS:

1. K. K. Chawla "Composite Materials: Science and Engineering", Springer, 2012.

2. Autar K. Kaw,"Mechanics of composite materials", Anne books New, Delhi 2006

REFERENCE BOOKS

1. P. K. Mallick"Fiber Reinforced Composites" , 3rd ed. CRC Press - 2014
2. Robert M. Jones"Mechanics of Composite Materials", 2nd ed., Taylor & Francis, 2015
3. MeingSchwaitz"Composite materials hand book," McGraw Hill book company.1984
4. Ronald F. Gibson"Principles of composite Material mechanics" 3rded Taylor & Francis, 2012.
5. MadhujitMukhopadhyay"Mechanics of Composite Materials and Structures", University Press 2009

REFRIGERATION AND AIR CONDITIONING

Sub Code:ME532E4	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course introduces the basic refrigeration process used in mechanical refrigeration and air conditioning systems. Topics include terminology, safety, and identification and function of components; refrigeration cycle; and tools and instrumentation used in mechanical refrigeration systems.

Course Objective:
1.Study the basic definition, ASHRAE Nomenclature for refrigerating systems
2. Understand the working principles and applications of different types of refrigeration systems
3.Study the working of air conditioning systems and their applications
4.Identify the performance parameters and their relations of an air conditioning system

Pre-requisites: Basic and Applied Thermodynamics

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: Illustrate the principles, nomenclature and applications of refrigeration systems.
CO2: Explain vapour compression refrigeration system and identify methods for performance improvement
CO3: Study the working principles of air, vapour absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems
CO4: Estimate the performance of air-conditioning systems using the principles of psychometry
CO5: Compute and Interpret cooling and heating loads in an air-conditioning system
CO6: Identify suitable refrigerant for various refrigerating systems

UNIT-I **10 Hours**
INTRODUCTION TO REFRIGERATION: –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications: Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air. Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, miscellaneous.

UNIT-II **10 Hours**
VAPOUR COMPRESSION REFRIGERATION SYSTEM(VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP – Ewing's construction and Gosney's method. Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure, Multi-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

UNIT-III **10 Hours**

VAPOUR ABSORPTION REFRIGERATION SYSTEMS: Absorbent – Refrigerant combinations, Water Ammonia Systems, Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems. Other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration systems.

UNIT-IV **10 Hours**

REFRIGERANTS: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropicmixtures.

REFRIGERATION SYSTEMS EQUIPMENT: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

UNIT-V **10 Hours**

AIR-CONDITIONING: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, ASHRAE Nomenclature pertaining to Air-Conditioning, Applications of Air-Conditioning, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems.

TRANSPORT AIR CONDITIONING SYSTEMS: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships.

TEXT BOOKS

1. Roy J. Dossat, "Principles of Refrigeration", Wiley Limited
2. Arora C.P., "Refrigeration and Air-conditioning", Tata Mc Graw –Hill, New Delhi, 2nd Edition,2001.
3. Stoecker W.F., and Jones J.W., "Refrigeration and Air-conditioning", Mc Graw - Hill, New Delhi 2nd edition, 1982.

REFERENCE BOOKS

1. Dossat, "Principles of Refrigeration" Pearson-2006.
2. McQuistion, "Heating, Ventilation and Air Conditioning", 5th edition, Wiley Students edition, 2000.
3. PITA, "Air conditioning" 4th edition, pearson-2005
4. Manohar prasad "Refrigeration and Air-Conditioning"
5. S C Arora& S Domkundwar, "Refrigeration and Air-Conditioning" Dhanpat Rai Publication

DATA BOOK

1. Shan K. Wang, Handbook of Air Conditioning and Refrigeration, 2/e, 2001 McGraw-Hill Education
2. Mathur M.L. &Mehta ,Refrigerant and Psychrometric Properties (Tables & Charts) SI Units,
F.S., Jain Brothers,2008

ENERGY ENGINEERING

Sub Code: ME532E5	**L:T:P**	**Total Lecture Hrs :46**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description:

This course reviews the relation between energy usage and quality of life, the social impact of energy use, and the environmental constraints. In particular, the role that engineering disciplines play in solving energy problems will be discussed. The full impact that the various energy alternatives have on economic and environmental issues will be reviewed to provide a rational basis for energy choices for the future

Course Objectives:

The objective of the course is to familiarize the students about the utilization of various alternative sources of energy technologies for thermal and electrical needs with environmental merits

Prerequisite:*Basics*

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Compare the types of fuels used in a power plant based their advantages and disadvantages
CO2: Design of chimney by calculating the height of chimney to produce a draft pressure and design of layout of a diesel power plant based on capacity.
CO3: Compare the advantages and disadvantages hydel and nuclear power plant.
CO4: Compare the advantages and disadvantages of wind, solar and tidal energy.
CO5: Describe the working of fuel cell, geothermal and bio-mass energy to understand the scope for each.

UNIT 1 **09 Hours**

Steam Power Plant: Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners

Pulverized Coal And Furnace: Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures

UNIT 2 **09 Hours**

Steam Generators: Chimneys - Natural, forced, induced and balanced draft, Calculations and numericals involving height of chimney to produce a given draft. Cooling towers and

Ponds, Accessories for the Steam generators such as Superheaters, Desuperheater, control of superheaters, Economizers, Air pre-heaters and re-heaters

Diesel Engine Power Plant: Applications of Diesel Engines in Power field, Method of starting Diesel engines, Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant

UNIT 3 **10 Hours**

Hydro-Electric Plants: Hydrographs, flow duration and mass curves, unit hydrograph and numericals. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves, General layout of hydel power plants

Nuclear Power Plant: Principles of release of nuclear energy; Fusion and fission reactions, Nuclear fuels used in the reactors, Multiplication and thermal utilization factors, Elements of the nuclear reactor; moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types - Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shieldings, Radio-active waste disposal

UNIT 4 **09 Hours**

Solar Energy: Solar Extra-terrestrial radiation and radiation at the earth surface, radiation-measuring instruments, working principles of solar flat plate collectors, solar pond and photovoltaic conversion (Numerical Examples)

Wind and Tidal Power:

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations

UNIT 5 **09 Hours**

OTEC, Geothermal Energy and Biomass: OTEC:Principle of working, Rankine cycle. Geothermal Energy Conversion:Principle of working, types of geothermal station with schematic diagram. Biomass: Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - pyrolysis, gasification, combustion and fermentation, Gasifiers, Digesters, economics of biomass power generation

Direct Energy Conversion Systems: Basic principle of Thermo-electric and Thermo-ionic power generations, Fuel cell - principle, types, applications, Magneto hydrodynamic power generation - Principle, open cycle and closed cycles, Hydrogen energy - Production, storage, and applications

TEXT BOOKS

1. P. K. Nag"Power Plant Engineering", Tata McGraw Hill, 4th ed. edn 2014
2. Domakundawar"Power Plant Engineering", Dhanpath Rai sons. 2015

REFERENCE BOOKS

1. R. K. Rajput "Power Plant Engineering", Laxmi publication, New Delhi
2. A. W. Culp Jr. "Principles of Energy conversion", McGraw Hill. 1996
3. G D Rai, "Non-conventional Energy sources", Khanna Publishers
4. B H Khan "Non-conventional resources", TMH - 2009

THEORY OF ELASTICITY

Sub Code: ME532E6	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course mainly deals with the elastic materials and the stress acting upon those elastic materials and the stresses acting in different dimensions and about torsional and thermal stresses.

Course Objectives:

- To study the behavior of the material within elastic limit.
- To analyze some real problem and to formulate the conditions of theory of Elasticity application
- To teach students to apply the methods of theory of elasticity in technical calculations on the basis of illustrative examples.
- To study the thermal state of stress and analyze torsional problems.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Understanding the stress-strain behavior with in elastic limit.
CO2: Understand the deformation, failure limit and loading capabilities.
CO3: Execute the stress state and stresses analysis Topic of Work, The stresses state analysis
CO4: Solve a problem of strain analysis Topic of Work: The strain state analysis
CO5: Use the numerical methods for the problem of the theory of elasticity in practice.

UNIT – 1 **10 Hours**

DEFINITION AND NOTATION: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions.

STRAIN AT A POINT: Compatibility Equations, Principal Strains, Generalized Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems.

UNIT – 2 **10 Hours**

TWO DIMENSIONAL PROBLEMS: Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure.

UNIT – 3 **09 Hours**

GENERAL EQUATIONS IN CYLINDRICAL CO-ORDINATES: Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration.

STRESSES IN AN INFINITE PLATE (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders.

UNIT – 4 **09 Hours**

TORSION OF CIRCULAR, ELLIPTICAL AND TRIANGULAR BARS: membrane analogy, torsion of thin open sections and thin tubes.

UNIT – 5 **10 Hours**

THERMAL STRESSES: Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere.

UNIQUENESS THEOREM: Principle of super position, reciprocal theorem, saint venant principle.

ESSENTIAL READINGS:

1. L. S. Srinath"Advanced Mechanics of solids" , Tata Mc. Graw Hill, 3rd edition, 2009.
2. S. P. Timoshenko and J. N Gordier "Theory of Elasticity", 3rd edition,Mc.Graw Hill International, , 2010

REFERENCE BOOKS:

1. Dr. Sadhu Singh,"Theory of Elasticity", Khanna Publications, 2012.
2. Martin H Sadd Elasticity, Theory, Applications & Numericals, 3rdedition,Elsevier,2014
3. Seetharamu & Govindaraju,"Applied Elasticity", Interline Publishing
4. C.T. WANG Sc. D"Applied Elasticity",.Mc. Graw Hill Book Co.1953

NON-DESTRUCTIVE TESTING

Sub Code: ME532E7	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Non-destructive Testing (NDT) plays an extremely important role in quality control, flaw detection and structural health monitoring covering a wide range of industries. There are varieties of NDT techniques in use. This course will first cover the fundamental science behind the commonly used NDT methods to build the basic understanding on the underlying principles. It will then go on to cover the process details of each of these NDT methods.

Course Objective:
NDT techniques are used for locating flaws as well as for characterizing material properties. Flaws within the materials canplay 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.

Course Outcomes:
Upon successful completion of this course, students should be able to:
CO1: Acquire the knowledge in the field of non-destructive testing and detect defects using NDT methods
CO2: Identify, recognize and select the necessary testing methods to inspect the parts
CO3: Evaluate and advise on the possibilities and limitations of a testing method
CO4: Describe, evaluate, monitor and improve the manufacturing processes
CO5: Understand Probability of Detection Concepts in Non-Destructive Testing
CO6: Know Codes, Standards, Specification and Procedures in non-destructive testing

UNIT -I **10 Hours**
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.

UNIT-II **10 Hours**
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.

UNIT-III **10 Hours**
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 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-IV **10 Hours**

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, Leak Testing Methods, Leak Detection, Bubble testing, Helium leak detector, Standards.

UNIT-V **10Hours**

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 NON-DESTRUCTIVE TESTING: 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.

TEXT BOOKS

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

REFERENCES

1. Prasad J, "Non-destructive Test & Evaluation of Materials", Tata McGraw-Hill, New Delhi, 2008.
2. Boyer, H.E, and T.L.Gall, "Metals Hand Book", American Society for Metals, 1988.

KNOWLEDGE MANAGEMENT

Sub Code: ME532E8	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course addresses contemporary issues in managing knowledge, intellectual capital and other intangible assets by discussing the fundamental concepts of knowledge and its creation, acquisition, representation, dissemination, use and re-use, the role and use of knowledge in organizations and institutions, knowledge management systems and its application in knowledge generation and transfer, and in the representation, organization, and exchange of knowledge, knowledge codification and system development, its testing, knowledge management tools and portals, and finally ethical, managerial and legal issues in knowledge management.

Course Objective:
The objective of this course is to prepare students to understand the current theories, practices, tools and techniques in knowledge management to deal with the challenges with the organization and management of knowledge.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: Understand the importance of intellectual capital to benefit in the competitive advantage and how to create conducive KM infrastructure in organizations.
CO2: Choose application packages in KM and the issues in designing and developing knowledge databases (including intranets and groupware).
CO3: Develop a working knowledge in the area through focused projects and career options.
CO4: Analyze impacts of implementation of KM infrastructure.
CO5: To understand the importance of intellectual capital and articulateto create the competitive advantage in manufacturing and other organizations.

UNIT-I
INTRODUCTION TO KNOWLEDGE MANAGEMENT:
Data, Information and Knowledge, KM Myths , KM Life Cycle, Understanding Knowledge, Knowledge, intelligence, Experience, Cognition. KM Types of Knowledge, Expert Knowledge, Human Thinking and Learning-Learning Organization-Characteristics, benefits, challenges of Learning Organization

UNIT-II
KNOWLEDGE MANAGEMENT SYSTEM LIFE CYCLE
Challenges in Building KM Systems – key differences of Conventional and KM System Life Cycle, Knowledge Creation.Knowledge Architecture – Nonaka's Model of Knowledge Creation and Transformation. Knowledge Architecture and its layers

UNIT-III
KNOWLEDGE CAPTURING
Evaluating the Expert – Developing a Relationship with Experts – Fuzzy Reasoning. The Quality of Knowledge – Knowledge Capturing or discovery Techniques, Brain Storming, storytelling, knowledge sharing,– Protocol Analysis – knowledge application systems (expert systems and decision support systems- Consensus Decision Making – Repertory Grid for competency mapping- Concept Mapping and use of software's.

UNIT-IV
KNOWLEDGE TRANSFER AND SHARING
Transfer Methods, Role of the Internet, Knowledge Transfer in e-world, KM System, Tools, Neural Network, Association Rules, Classification Trees, and Data Mining. Business Intelligence, Decision Making Architecture, Data Management, Knowledge Management Protocols, Managing Knowledge Workers.

UNIT- V
KNOWLEDGE MANAGEMENT IN MANUFACTURING
How to foster innovation within own organizations - policy adoption of new 08 University of Mumbai, ME (Mechanical) Manufacturing Systems Engineering, Rev 2016 20 management methods, to actual innovation or to ICT use, organizational responsiveness, innovation, competency and efficiency (RICE), knowledge sharing, utilization and its evaluation, Knowledge value chain, illustrative case studies in manufacturing.

REFERENCES
1. Elias.M. Award & Hassan M. Ghaziri – "Knowledge Management" Pearson Education 2003.
2. Guus Schreiber, Hans Akkermans, Anjo Anjewierden, Robert de Hoog, Nigel Shadbolt, Walter Van de Velde and Bob Wielinga, "Knowledge Engineering and Management", Universities Press, 2001.
3. C.W. Holsapple, "Handbooks on Knowledge Management", International Handbooks on Information Systems, Vol 1 and 2, 2003
4. Davenport, Thomas H. & Prusak, Laurence(2000). "Working Knowledge: How Organizations Manage What They Know". Boston, MA: Harvard Business School Press.
5. Nonake, Ikujiro & Takeuchi, Hirotaka. (1995) "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation". 2010

STATISTICAL QUALITY CONTROL

Sub Code: ME532E9	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course has been designed for both upper level of undergraduate and graduate students for various discipline. The focus of this course is on both applications and theory. Modern statistical methods will be used for quality control and improvement.

Course Objective:
Understand the objectives, functions, and economic aspects ofindustrial inspection. Understand the essential components/ economics for building qualityand study the evolution of the concepts/ tools of quality engineering. Study the basics andapplications of various statistical quality control techniques and also process capabilityanalysis. Study and understand the concepts of quality improvement process and theassociated quality tools. Understand the scope and significance of engineering metrology

Course outcomes:
Upon completion of this course, student will be able to:
CO1: Analyze different statistical methods for statistical process control.
CO2: Assess general advantages and disadvantages for alternative process control methods
CO3: Identify the different quality control techniques for varying sampling methods
CO4: Formulate an adequate statistical control problem for a production or similar process.
CO5: Estimate the quality measures in general by means of modern and relevant statistical tools.

UNIT – I **10 Hours**
INTRODUCTION: The Meaning of Quality and Quality Improvement; Brief History ofQuality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement).

UNIT - II **10 Hours**
MODELING PROCESS QUALITY: Mean, Median, Mode, Standard deviation, Calculatingarea, The Deming funnel experiment, Normal distribution tables, Finding the Z score, Central limit theorem.
METHODS OF STATISTICAL PROCESS CONTROL: Chance and assignable causes,Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL)

UNIT - III **10 Hours**
CONTROL CHARTS FOR VARIABLES: Control Charts for X-Bar and R- Charts, Statisticalbasis of the charts, Development and use of X bar and R charts, Interpretation of charts. Type I and Type II errors, the probability of Type II error. Numerical Problems.

UNIT - IV **10 Hours**
PROCESS CAPABILITY: The foundation of process capability, Natural Tolerance limits, C_p–process capability index, Cp_k, pp – process performance index, summary of process measures. Numerical problems

UNIT V **10 Hours**

Control Charts For Attributes: Binomial distribution, Poisson distribution (from the pointof view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit. Numerical problems

LOT-BY-LOT ACCEPTANCE SAMPLING FOR ATTRIBUTES: The acceptance samplingproblem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Military Standard 105E, the Dodge-Romig sampling plans. Numerical problems

TEXT BOOKS

1. E.L. Grant and R.S. Leavenworth **"Statistical Quality Control"**, 7th edition, McGraw-Hillpublisher.
2. R C Gupta **"Statistical Quality Control"**, Khanna Publishers, New Delhi, 2005

REFERENCE BOOKS

1. Gerald M. Smith **"Statistical Process Control and Quality Improvement"**, PearsonPrentice Hall. ISBN 0 – 13-049036-9.
2. W S Messina **"Statistical Quality Control for Manufacturing Managers"**, Wiley & Sons,Inc. New York, 1987
3. Montgomery, Douglas **"Statistical Quality Control"**, 5thEdition, John Wiley & Sons, Inc.2005, Hoboken, NJ (ISBN 0-471-65631-3).
4. Jerry Banks **"Principles of Quality Control"**, Wiley & Sons, Inc. New York.

MICRO AND SMART SYSTEMS TECHNOLOGY

Sub Code: ME 532E10	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description:
This interdisciplinary course not only gives an overview of the micro and smart systems technologies but also gives an in-depth understanding of the issues involved. It begins by answering the important question: why miniaturize? This is followed by a quick summary of a variety of sensors, actuators, and systems. It then presents a comprehensive description of micro fabrication. This is followed by a detailed discussion of mechanics of solids as it pertains to micro and smart systems. While this part may be viewed as strength of materials and design, an effort is made to relate this to micro devices and discuss such topics as residual stress and stress gradients, lumped modelling using energy methods, anticlastic curvature, etc.

Course Objective:
Micro and smart system technologies have immense application potential in many fields. In the coming decades, scientists and engineers would be required to design and develop such systems for varied applications. It is essential then that graduating engineers be exposed to the underlying science and technology

Course Outcome:
Upon completion of this course, the students will be able to
CO1: Classify micro sensors and actuators and design smart systems.
CO2: Understand the role of smart actuators in micro machining.
CO3: Construct models of micro systems using conventional modelling techniques.
CO4: Compute response of an electro mechanical smart system using finite element method.
CO5: Study the reliability of electronic circuits and control methods used to develop micro and smart systems.
CO6: Understand methods for integration of micro and smart systems.

UNIT-I **10 Hours**
INTRODUCTION: Overview of Micro and smart systems, Processing of Sensors, Actuators and micro structures, Applications in diverse fields including Biomedical, Defense, Automobile and Aerospace Engineering.

UNIT-II **10 Hours**
MICRO FABRICATION PROCESSES: Overview of Micro Machining Technologies, miaturization, conventional and silicon micro machining techniques, Ultrasonic machining, sandblasting, laser ablation, spark erosion and photo lithography.

UNIT-III **10 Hours**
MODELLING AND MECHANICS: Solid mechanics concepts for Micro and smart systems, Solid Modelling in Micro systems.

UNIT-IV **10 Hours**
FINITE ELEMENT METHOD: FEM applications for modelling and analysis of Coupled Electromechanical Systems.

UNIT-V **10 Hours**

ELECTRONICS AND PACKAGING: Integration of mechanical components with electronics, Electronic circuits and control for micro and smart systems, scaling effects

REFERENCES

1. G. K. Anantha Suresh, "Micro and Smart Systems", Wiley India Pvt. Ltd., 2010.
2. G. K. Anantha Suresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, V. Kasudev Aatre, "Micro and Smart Systems: Technology and Modeling", John Wiley & Sons, 2012.
3. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", Tata McGraw Hill Education Private Limited, 2002

CRYOGENICS

Sub Code: ME735E1	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course is aimed at students who are interested to study the science and technology of low temperatures. This course provides instruction in fundamental principles of cryogenics, developing these into tools that can be utilized in laboratory and industrial applications. The topics will include a brief history of cryogenics, material properties (solids, liquids, and gases) at low temperatures, cryocooler systems for refrigeration and liquefaction, measurement techniques, and the safe storage and transfer of cryogenics

Course Objectives:

- This course is aimed at students who are interested to study the science and technology of low temperatures.
- This course provides instruction in fundamental principles of cryogenics, developing these into tools that can be utilized in laboratory and industrial applications.
- The topics will include a brief history of cryogenics, material properties (solids, liquids, and gases) at low temperatures, cryocooler systems for refrigeration and liquefaction, measurement techniques, and the safe storage and transfer of cryogenics

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Demonstrate applications of Cryogenic engineering with examples and will be able to differentiate the properties of materials at low temperature.
CO2: Demonstrate working principle of gas liquefaction and gas cycle cryogenic refrigeration system by comparing liquefaction cycles and by classifying cryo-coolers.
CO3: Explain principles of gas separation in Linde single column/double column air separation system and will be able to compare with thermodynamic ideal separation system.
CO4: Explain the fundamental principles of vacuum technology with examples and will be able to relate and compare with cryogenic insulation by solving problems using first principles of Heat transfer due to conduction, convection and radiation.
CO5: Design of cryogenic fluid storage vessels for a given application

Prerequisite: Basic Thermodynamics

UNIT 1 **10 Hours**

INTRODUCTION TO CRYOGENIC SYSTEMS: Applications Areas of Cryogenic Engineering, Low temperature properties of engineering materials – Mechanical properties, Thermal properties, Electrical properties

INTRODUCTION TO THERMODYNAMICALLY IDEAL SYSTEM: Production of low temperatures – Joule Thompson Effect, Adiabatic expansion

UNIT 2 **10 Hours**

GAS LIQUIFICATION SYSTEMS: Liquification systems for Air Simple Linde – Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System, Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems

GAS CYCLE CRYOGENIC REFRIGERATION SYSTEMS: Classification of Cryo coolers, Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt‟s analysis of Stirling cycle Various configurations of Stirling cycle refrigerators Integral piston Stirling cryo-cooler, Free displacer split type Stirling Cryo coolers, Gifford Mcmahon Cryo-refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators

UNIT 3 **10 Hours**

GAS SEPARATION AND GAS PURIFICATION SYSTEMS: Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation, Linde double column air separation, Argon and Neon separation systems, Adsorption Process, PSA systems

ULTRA LOW TEMPERATURE CRYO – REFRIGERATORS: Magneto Caloric Refrigerator, 3He-4He Dilution refrigerator, Pomeranchuk cooling, Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry, Liquid level sensors

UNIT 4 **09 Hours**

VACUUM TECHNOLOGY: Fundamental principles, Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level

CRYOGENIC INSULATION: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation

UNIT 5 **09 Hours CRYOGENIC**

FLUID STORAGE AND TRANSFER SYSTEMS: Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines, Cryogenic fluid transfer, External pressurization, Self-pressurization, Transfer pump

APPLICATION OF CRYOGENIC SYSTEMS: Cryogenic application for food preservation, Instant Quick Freezing techniques 11.2 Super conductive devices, Cryogenic applications for space technology

TEXT BOOKS:

1. Randall Barron, "Cryogenic Systems", Oxford Press, 1985
2. Thomas M. Flynn"Cryogenic Engineering", 2nd ed. Marcel Dekker, Inc N.Y. Basal 2005

REFERENCE BOOKS

1. Klaus D. Timmerhaus& Thomas "Cryogenic Process Engineering", M. Flynn, Plenum Press, New York & London 1989
2. A.Bose and P.Sengupta, "Cryogenic: Application and progress", Tata McGraw Hill
3. G. Walker,"Cryo-Cooler: Fundamentals Part-I" , Springer, 2014
4. G. Walker"Cryo-Cooler: Fundamentals Part-II" , Springer, 2012

GAS DYNAMICS AND SPACEPROPULSION

Sub Code: ME735E2	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Gas dynamics is the field of study associated with the forces and motion of gasses. It is a subset of the general field of fluid dynamics that considers liquids in addition to gasses. Many fluids can be considered incompressible. This provides a degree of simplification to the equations that govern the motion of the fluid. A gas is compressible and the coupling between the fluid properties such as density, pressure, and temperature creates a close link between gas dynamics and thermodynamics. Choked flow and shock waves are two phenomena that are encountered with gases that are not generally encountered with liquids. These phenomena are directly related to compressibility effects. The second part of the course deals with rocket propulsion and imparts a basic knowledge on different space propulsion techniques

Course Objectives:

- Introduce the fundamentals of compressible fluid flow, with an emphasis on a wide variety of steady, one-dimensional flow problems and a general understanding of the principles of expansion waves
- Provide the fundamentals of rocket propulsion, with an emphasis on understanding different means of propulsion

Course Outcomes:

Upon completion of the course, students will be able to

CO1: Formulate and solve problems in one -dimensional steady compressible flow including: isentropic nozzle flow, constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayleigh flow)
CO2: Derive the conditions for the change in pressure, density and temperature for flow through a normal shock
CO3: Determine the strength of oblique shock waves on wedge shaped bodies and concave corners
CO4: Determine the change in flow conditions through a Prandtl-Meyer expansion wave explain the measurement techniques for compressible flow
CO5: Demonstrate an understanding of fundamentals of chemical rocket performance; how liquid and solid propellant rockets work

Prerequisite: Basic Thermodynamics, Fluid Mechanics

UNIT 1 **10 Hours**

BASIC CONCEPTS: Introductory Concepts to Compressible Flow- Concept of continuum system and control volume approach- conservation of mass, momentum and energy- stagnation state- compressibility- Mach number- Effect of Mach number on compressibility-

Pressure coefficient-Physical difference between incompressible, subsonic and supersonic flows - Mach cone

ISENTROPIC FLOWS: One dimensional steady isentropic flow- Adiabatic and isentropic flow of a perfect gas- basic equations- Area-Velocity relation using 1D approximation nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser- working tables-charts and tables for isentropic flow

UNIT 2 **10 Hours**

FLOW IN A CONSTANT AREA DUCT WITH FRICTION (FANNO FLOW): Governing Equations- Fanno line on h-s and P-v diagram- Fanno relation for a perfect gas- Chocking due to friction- Simple numerical

FLOW THROUGH CONSTANT AREA DUCT WITH HEAT TRANSFER (RAYLEIGH FLOW): Governing equations- Rayleigh line in h-s and P-v diagram-Rayleigh relation for perfect gas- Simple numerical

UNIT 310 Hours NORMAL AND OBLIQUE SHOCKS: Governing equations, Variation of flow parameters across the normal and oblique shocks, Prandtl – Meyer relations, Use of table and charts, Applications, Simple numerical

COMPRESSIBLE FLOW FIELD VISUALIZATION AND MEASUREMENT: Shadowgraph, Schlieren technique, interferometer, subsonic compressible flow field measurement (Pressure, Velocity and Temperature), compressibility correction factor, hot wire anemometer, supersonic flow measurement, Rayleigh Pitot tube, wedge probe, stagnation temperature, probe- temperature

UNIT 410 Hours

FUNDAMENTALS OF ROCKET PROPULSION: Operating principle, Specific impulse of a rocket, internal ballistics, Rocket nozzle classification, Rocket performance considerations

SOLID PROPELLANT ROCKET: Solid propellant rockets, Selection criteria of solid propellants, Important hardware components of solid rockets, Propellant grain design considerations

UNIT 5 **09 Hours**

LIQUID PROPELLANT ROCKET: Liquid propellant rockets, Selection of liquid propellants, Cooling in liquid rockets, Hybrid rockets

ADVANCED PROPULSION TECHNIQUES: Electric rocket propulsion, Ion propulsion techniques, Nuclear rocket, Types, Solar sail, Preliminary Concepts in nozzleless propulsion

TEXT BOOKS

1. Anderson, J.D Jr."Modern Compressible Flows", Tata McGraw Hill, 2017.
2. Yahya.S.M, "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd, New Delhi, 2017.
3. Radhakrishnan.E, "Gas Dynamics", PHI Learning Pvt. Ltd, 6th edition, 2017.
4. Zucrow, M., Gas Dynamics, Wiley India, 2013

DATA BOOK

1. Yahya.S.M, "Gas Tables for compressible flow calculations", New Age International (P) Ltd, New Delhi, 6th edition, 2011

REFERENCE BOOKS

1. Mattingly.J.D, "Elements of Propulsion: Gas turbines and Rockets", McGraw Hill, 2012
2. Balachandran.P, "Fundamentals of compressible fluid dynamics", PHI Learning, 2012
3. Robert.D.Zucker, "Oscar Biblarz, Fundamentals of Gas Dynamics"2nd edition, John Wiley and Sons, , 2011

POWER PLANT ENGINEERING

Sub Code: ME735E3	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course is concerned with the types, construction, working principles and performance of different types of conventional and non-conventional power plants. The design, construction, operation and performance of various components of steam, gas and diesel power plant e.g condensers, cooling towers, fuel and air handling systems, steam generators, superheaters, intercoolers, reheaters and regenerators. It also discusses the basics of nuclear energy and operation of nuclear power plants. The course also covers basics of plant economics and the impact of power plants on the environment

Course Objectives:

- To provide basic knowledge of different types of power plants, site selection criteria for each one of them
- To analyze different types of steam cycles and estimate efficiencies in a steam power plant
- To describe basic working principles of gas turbine, diesel engine and hydroelectric power plants
- Basic knowledge of Different types of Nuclear power plants including Pressurized water reactor, Boiling water reactor, gas cooled reactor, liquid metal fast breeder reactor.
- To define terms and factors associated with power plant economics

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Differentiate the type of fuels used for steam generation by comparing the advantages of using pulverized fuel.
CO2: Design chimneys by calculating height of chimney to produce a given draft. Design layout of diesel power plant based on capacity.
CO3: Compare the advantages and disadvantages of the open and closed cycle gas turbine plant.
CO4: Explain working principle of nuclear power plant with examples. Appraise on radiation hazards and devise a radioactive waste disposal solution.
CO5: Determine load estimation, load duration curve, load factor etc. and select the number and size of the units. Selection of plants and determine the cost of production

UNIT 1 **10 Hours**

POWER STATION: General Sources of power, Importance of Central Power Stations, Types of power stations – steam, Nuclear, Diesel and hydro

ELEMENTS OF POWER STATION: Elements of modern power stations (Steams only) brief layout and arrangement of elements and complements, Sitting of different power stations, Foundation, Elements of Electric power systems primary and secondary distribution substations (in brief)

UNIT 2 **10 Hours**

STEAM POWER PLANT: Steam power plants selection of working medium, Heat Balance in steam cycles, Heat rates, Comparison of efficiencies gas loop, Fuels and fuel handling System and Ash handling System

STEAM BOILERS: Air pre-heater, Feed water pre-heaters, Steam re-heaters, Dearators, Feed water treatment, Pumping and regulation water walls, Modern developments in steam boilers, Important instrumentation and piping of gas and water loop. Factors to be controlled from maximum efficiency and variable output

UNIT 3 **09 Hours**

HYDRO ELECTRIC POWER STATION: Potential power with reference to rainfall and catchments area, Water storage, Equipment used in hydro-electric power stations, Characteristics of hydraulic turbines, Comparison of the factors governing the cost of hydro steam and diesel power stations

DIESEL POWER STATION: Application of Diesel in power field, Suitability of diesel engines for bulk power, Layout of Diesel Power Plant, Advantages and limitations of diesel, Power stations, Performance Characteristics

UNIT 4 **09 Hours**

NUCLEAR POWER STATION: Evolution of nuclear energy from atoms by fission and fusion, Chain reactions, Fission materials, Types of reactors, gas cooled, Boiling water liquid, Metal cooled and fast reactor, Arrangements of various elements in a nuclear power station, Steam cycles and boilers coolant heat exchangers, Reactor control, Reactor shielding and safety methods

UNIT 5 **09 Hours**

VARIABLE LOAD PROBLEMS: Idealized and realized load curves, Effect of variable load on plant design and operation variable load operation and load dispatch

Power Station Economics: Source of income, Cost of plant and production, Elements of cost, depreciation and replacement theory of rates.

TEXT BOOKS:

1. P.K. Nag, "Power Plant Engineering", 4th Edition, Tata McGraw-Hill Pub. Com., New DELHI, 2014
2. R.K. Rajput, A Text Book of "Power Plant Engineering", Laxmi Publications, 5th edition, 2016.
3. Arora, Domkundwar, "Power Plant Engineering", Dhanpat Rai & Co., 2016

REFERENCE BOOKS

1. F.T. Morse, "Power Plant Engineering", Affiliated East – West Press Pvt. Ltd., New Delhi, 2008.
2. M.M. El. Wakil, "Power Plant Technology"– McGraw Hill, International Edition 1984
3. G.R.Nagpal, "Power Plant Engineering", 17th edition, Khanna Publishers, 2016.
4. R.Yadav, "Fundamental of Power Plant Engineering", Central Publishing House Allahabad,2011

THEORY OF ELASTICITY

Sub Code: ME735E4	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course mainly deals with the elastic materials and the stress acting upon those elastic materials and the stresses acting in different dimensions and about torsional and thermal stresses.

Course Objectives:

- To study the behavior of the material within elastic limit.
- To analyze some real problem and to formulate the conditions of theory of Elasticity application
- To teach students to apply the methods of theory of elasticity in technical calculations on the basis of illustrative examples.
- To study the thermal state of stress and analyze torsional problems.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Understanding the stress-strain behavior with in elastic limit.
CO2: Understand the deformation, failure limit and loading capabilities.
CO3: Execute the stress state and stresses analysis Topic of Work, The stresses state analysis
CO4: Solve a problem of strain analysis Topic of Work: The strain state analysis
CO5: Use the numerical methods for the problem of the theory of elasticity in practice.

UNIT – 1 **10 Hours**

DEFINITION AND NOTATION: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions.

STRAIN AT A POINT: Compatibility Equations, Principal Strains, Generalized Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems.

UNIT – 2 **10 Hours**

TWO DIMENSIONAL PROBLEMS: Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure.

UNIT – 3 **09 Hours**

GENERAL EQUATIONS IN CYLINDRICAL CO-ORDINATES: Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration.

STRESSES IN AN INFINITE PLATE (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders.

UNIT – 4 **09 Hours**

TORSION OF CIRCULAR, ELLIPTICAL AND TRIANGULAR BARS: membrane analogy, torsion of thin open sections and thin tubes.

UNIT – 5 **10 Hours**

THERMAL STRESSES: Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere.

UNIQUENESS THEOREM: Principle of super position, reciprocal theorem, saint venant principle.

ESSENTIAL READINGS:

1. L. S. Srinath"Advanced Mechanics of solids" , Tata Mc. Graw Hill, 3rd edition, 2009.
2. S. P. Timoshenko and J. N Gordier "Theory of Elasticity", 3rd edition,Mc.Graw Hill International, , 2010

REFERENCE BOOKS:

1. Dr. Sadhu Singh,"Theory of Elasticity", Khanna Publications, 2012.
2. Martin H Sadd Elasticity, Theory, Applications & Numericals, 3rdedition,Elsevier,2014
5. Seetharamu & Govindaraju,"Applied Elasticity", Interline Publishing
6. C.T. WANG Sc. D"Applied Elasticity",.Mc. Graw Hill Book Co.1953

EXPERIMENTAL STRESS ANALYSIS

Sub Code: ME735E5	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course deals with the various methods of stress analysis done experimentally and the instruments used for the stress analysis and the methods to conduct the stress analysis.

Course Objectives:

- To understand the relation between the mechanics theory and experimental stress analysis.
- To establish the fundamental concepts and newly experimental techniques.
- To be able to use the experimental techniques on the practical problems.
- To be able to make a fine presentation related to the experimental paper.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1:Explain characterize the elastic behavior of solid bodies

CO2:Explain stress strain analysis of mechanical systems using electrical resistance strain gauges

CO3:Develop skills for experimental investigations by accompanying laboratory course

CO4:Examine experimental investigations by predictions by other methods

CO5:Compare various coating techniques

UNIT-1 **10 Hours**

ELECTRICAL RESISTANCE STRAIN GAGES: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits.

STRAIN ANALYSIS METHODS: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

UNIT-2 **09 Hours**

PHOTOELASTICITY: Nature of light, Wave theory of light - optical interference , Stress optic law – effect of stressed model in plane and circuclar polariscopes, Isoclinics & Isochromatics, Fringe order determination Fringe multiplication techniques , Calibration photoelastic model materials

UNIT-3 **10 Hours**

TWO DIMENSIONALPHOTOELASTICITY: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photoelastic model materials, Materials for 2D photoelasticity

THREE DIMENSIONAL PHOTO ELASTICITY: Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses.

UNIT-4 **09 Hours**

PHOTOELASTIC(BIREFRINGENT) COATINGS: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings

Brittle COATINGS: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation
techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

UNIT-5 **09 Hours**

MOIRE METHODS: Moire fringes produced by mechanical interference .Geometrical approach,
Displacement field approach to Moire fringe analysis ,0ut of plane displacement measurements, Out of plane slope measurements .Applications and advantages

TEXT BOOKS:

1. Dally and Riley, "Experimental Stress Analysis", McGraw Hill, 1991.
2. Sadhu Singh, “Experimental Stress Analysis", Khanna publisher, 2009.
3. Srinath L.S, “Experimental stress Analysis”, tata Mc Graw Hill, 1984.

REFERENCES BOOKS:

1. M.M.Frocht, "Photoelasticity Vol I and Vol II”, John Wiley & sons, 1989.
2. Perry and Lissner, "Strain Gauge Primer", Mc Graw Hill, 1962.
3. Kuske, Albrecht & Robertson, "Photo Elastic Stress Analysis", John Wiley & Sons, 1974.
4. Dave and Adam,"Motion Measurement and Stress Analysis",

DESIGN OF EXPERIMENTS

Sub Code: ME735E6	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This Course deals with the experiment design which means the optimization of the steps taken to design an experiment and the various techniques involved in design an experiment.

Course Objectives:

- To understand the techniques involved in designing an experiment.
- To establish the basic statistical concepts in designing and experiment.
- To obtain the knowledge of taguchi method which is the efficient method of experimental design.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: To describe the basic statistical tools and concepts
CO2: To select the appropriate DOE experiment type for a given application
CO3: To describe the concept of ANOVA method.
CO4: To set-up and analyze Partial Factorial DOEs, simple Robust Design (Taguchi) DOEs, and simple Response Surface DOEs.
CO5: To determine the quality by experimental design

UNIT – 1 **10 Hours**

INTRODUCTION: Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

BASIC STATISTICAL CONCEPTS: Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size.Illustration through Numerical examples.

UNIT – 2 **10 Hours**

EXPERIMENTAL DESIGN: Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

ANALYSIS AND INTERPRETATION METHODS: Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

UNIT – 3 **10 Hours**

QUALITY BY EXPERIMENTAL DESIGN: Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples.

EXPERIMENT DESIGN USING TAGUCHI'S ORTHOGONAL ARRAYS: Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.

UNIT – 4 **09 Hours**

SIGNAL TO NOISE RATIO: Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples.

UNIT – 5 **09Hours**

PARAMETER AND TOLERANCE DESIGN: Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical examples.

Essential Readings:

1. Douglas C. Montgomery"Design and Analysis of Experiments", 8 th Edition Wiley India Pvt. Ltd. 2013

2. Madhav S. Phadke"Quality Engineering using Robust Design", Prentice Hall PTR, Englewood Cliffs, New Jersy 07632, 1989.

REFERENCE BOOKS:

1. Thomas B. Barker, Marcel Dekker"Quality by Experimental Design" , Inc ASQC Quality Press.4th edition2016

2. C.F. Jeff Wu Michael Hamada, "Experiments Planning, analysis, and parameter Design optimization" John Wiley Editions.2ndedition, 2009.

3. W.L. Condra, Marcel Dekker"Reliability Improvement by Experiments" 2ndedition , Inc ASQCQuality Press. 2001

4. Phillip J. Ross"Taguchi Techniques for Quality Engineering", 2 ndEdn. McGraw Hill International Editions, 1996.

ORGANISATIONAL BEHAVIOUR & PROFESSIONAL COMMUNICATION

Sub Code: ME735E7	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: 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.

Course Objectives:

- To gain a solid understanding of human behavior in the workplace from an individual, group, and organizational perspective.
- To obtain frameworks and tools to effectively analyze and approach various organizational situations.
- To integrate course materials with your own workplace experiences.
- To reflect upon your own beliefs, assumptions, and behaviors with respect to how individuals, groups, and organizations act in order to expand your options of approaches and increase your own effectiveness.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1:To communicate in an effective manner in an organization.
CO2:To motivate the team members in an organization.
CO4: To study the various methods of learning.
CO5:To effectively manage the stress and conflicts in an organization.

UNIT – 1 **14 Hours.**
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.

UNIT – 2 **14 Hours.**
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**.**

UNIT – 3 **12 Hours.**
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**.**

UNIT – 4 **10 Hours.**

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**.**

UNIT – 5 **10 Hours.**

PRINCIPLES 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**.**

Essential Readings:

1. Organizational Behaviour, Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002

2. Organizational Behaviour, Fred Luthans, 9th Edition, Mc Graw Hill International Edition, ISBN-0-07-120412-12002

REFERENCE BOOKS

1. Organizational Behaviour, Hellriegel, Srocum and Woodman, Thompson Learning, 9th Edition, Prentice Hall India, 2001
2. Organizational Behaviour, Aswathappa - Himalaya Publishers. 2001
3. Organizational Behaviour, VSP Rao and others, Konark Publishers.2002
4. Organizational Behaviour, (Human behaviour at work) 9th Edition, John Newstron/ Keith Davis. 2002

TOTAL QUALITY MANAGEMENT

Sub Code: ME735E8	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course deals with the various aspects of quality followed in an organization in developing a product and also in developing the organization.

Course Objective:

- Summarize the philosophy and core values of Total Quality Management (TQM).
- Recognize the voice of the customer and the impact of quality on economic performance and long-term business success of an organization.
- Analyze best practices for the attainment of total quality.
- To create process improvement teams trained to use the various quality tools for identifying appropriate process improvements.
- Construct a strategy for implementing TQM in an organization.

Course Outcomes:

Upon completion of the subject, students will be able to

CO1: Identify the importance of quality in product and service to sustain in global market by TQM frame work.
CO2: Asses the voice of customer, employee suggestion for improving the quality of the product and service with help Kano model, TEBOUL model, Maslow hierarchy, Herzberg two factors methods.
CO3: Explain problem solving methods to identify the obstacle on the way of implantation of total quality tools to improve quality of product and service and how to resolve it.
CO4: Evaluate the given market situation using quality management tool and statistical process control tools namely tree diagram ,matrix diagram, pareto diagram , histogram, cause and effective diagram
CO5: Develop a strategy for implementing TQM in an Organization by self-assessment, ISO Concept and Six Sigma.

UNIT – 1 **10 Hours**

PRINCIPLES AND PRACTICE: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.

LEADERSHIP: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

UNIT – 2 **10 Hours**

CUSTOMER SATISFACTION AND CUSTOMER INVOLVEMENT: CUSTOMER SATISFACTION : customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, Case studies.

EMPLOYEE INVOLVEMENT – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gainsharing, performance appraisal, unions and employee involvement, case studies.

UNIT – 3 **09 Hours**

CONTINUOUS PROCESS IMPROVEMENT: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.
TOOLS AND TECHNIQUES: Benching marking, information technology, quality management systems, environmental management system, quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.

UNIT – 4 **09 Hours**

QUALITY MANAGEMENT TOOLS : Why Why, forced filed analysis, nominal group technique, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, prioritization matrices, process decision program chart, activity network diagram.

STATISTICAL PROCESS CONTROL : Pareto diagram, process flow diagram, cause-and-effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

UNIT – 5 **09 Hours**

BUILDING AND SUSTAINING PERFORMANCE EXCELLENCE IN ORGANIZATIONS : Making the commitment to total quality, organizational culture and total quality, change management, sustaining the quality organization, self-assessment processes, implementing ISO 9000, Baldrige, and six sigma, a view toward the futures

DESIGN FOR SIX SIGMA: Tools for concept development, tools for design development, tools for design optimization, tools for design verification, problems.

TEXT BOOKS

1. Dale H. Bester field, "Total Quality Management", Dale H. Bester field, Publisher - Pearson Education India, ISBN: 8129702606, Edition 03,2011
2. M. Zairi, "Total Quality Management for Engineers": ISBN: 1855730243, Publisher: Wood head Publishing

REFERENCE BOOKS

1.Shoji Shiba, Alan Graham, David Walden, "A New American TQM", four revolutions in management, Productivity press, Oregon, 1993.

2. Gopal K. Kanji and Mike Asher, "100 Methods for Total Quality Management": ISBN: 8170365716.,New Delhi Vistaar Publications 2009

3. H. Lal, "Total Quality Management: A Practical Approach" ISBN: 9788122402421New Age Internations (P) Ltd 2009

SMART MATERIALS

Sub Code: ME832E1	**L:T:P**	**Total Lecture Hrs :46**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course description: Provides basic knowledge about the characteristics and uses of Smart Materials.

Course objectives

- To differentiate smart materials and categorize their applications in various disciplines.
- To interpret the physical principles and the multi-physics coupling effects occurring in smart materials.
- To provide an insight into the latest developments regarding smart materials and their use in structures.

Course outcomes:

Upon completion of the subject, students will be able to

CO1: Describe the concept of structure-property relations.
CO2: Define the properties of smart materials in various domains.
CO3: Explain the process of synthesis of smart systems and smart materials.
CO4: Analyze the smart systems for various engineering applications.
CO5: Describe the concept of intelligent processing of semiconductors and metals.

Level of Knowledge: Basic Science

UNIT – 1 **09 Hours**

INTRODUCTION: Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics

UNIT - 2 **08 Hours**

SENSING AND ACTUATION: Principals of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, their compatibility writer conventional and advanced materials, signal processing, principals and characterization.

UNIT – 3 **10 Hours**

CONTROL DESIGN: Design of shape memory alloys, Types of MR fluids, Characteristics and application, principals of MR fluid value designs, Magnetic circuit design, MR Dampers, Design issues.

OPTICS AND ELECTROMAGNETIC: Principals of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles.

UNIT-4 **10 Hours**

STRUCTURES: Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects.

CONTROLS: Principles of structural acoustic control, distributed, analog and digital feedback controls, Dimensional implications for structural control.

UNIT - 5 **09 Hours**

PRINCIPLES OF VIBRATION AND MODAL ANALYSIS: PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics and Applications.

INFORMATION PROCESSING: Neural Network, Data Processing, Data Visualization and Reliability – Principals and Application domains.

TEXT BOOKS:

1. A. V. SrinivasanSmart Structures Analysis and Design‟, Smart Structures –Cambridge University Press, New Delhi, 2010,
2. ‟, M V Gandhi and B S Thompson "Smart Materials and Structures" Chapmen & Hall, London, 1992

REFERENCE BOOKS

1. RC Smith, Y Wang, Massow S A"Smart Materials and Structures‟, Banks HT, , Paris 1996
2. G P Gibss , Clark R L, W R Saunolers ‟Adaptive Structures", Jhon Wiles and Sons, New York, 1998
3. Eric Udd,"Fiber optic sensors: An introduction for scientists and Engineers‟, Jhon Wiley & Sons, New York, 2011

PRODUCT DESIGN AND MANUFACTURING

Sub Code: ME832E2	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Understanding the current economy for manufacturing of the product is important factor. This course give basics knowledge related to non traditional machining process, martial stiffness and man machine information exchange etc.

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

Level of Understanding: Basic

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Assess the proposal of design and production consumption cycle by Asimow's model
CO2: Determine the time to market and Strength, Stiffness of the product
CO3: Detect the sub assembly components design and to optimise the design
CO4: Develop a safety design, pricing design, and aesthetic design of a product
CO5: Determine the product value and to evaluate the creativity

UNIT-1 **10 Hours**

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.

UNIT-2 **10 HoursPRODUCT 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.

UNIT-3 **10 Hours**

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.

UNIT-4 **10 Hours**

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.

UNIT-5 **09 Hours**

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).

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.

NANOTECHNOLOGY

Sub Code: ME832E3	**L:T:P**	**Total Lecture Hrs :47**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: Provides basic knowledge about the science of Nanotechnology

Course Objectives:

- To provide a broad technical picture of nanotechnology to engineering students from various engineering disciplines.
- Describe the structure, properties, manufacturing, and applications of silicon and carbon materials.
- Explain the fabrication methods in nanotechnology (top down & bottom up).
- Categorize the characterization methods in nanotechnology (optical, electrical, AFM, SEM, TEM, and nano-indentation)

Level of Learning: Basic

Course Outcomes:

Upon completion of the subject, students will be able to

CO1: Apply engineering and physical concepts to the nano-scale and non-continuum domain.
CO2: Demonstrate a comprehensive understanding of state-of-the-art nano-fabrication methods.
CO3: Evaluate processing conditions to engineer functional nanomaterials.
CO4: Apply and transfer interdisciplinary systems engineering approaches to the field of bio- and nanotechnology projects.
CO5: Describe state of the art characterization methods for nano materials.

UNIT–1 **09 Hours**

BASICS OF NANOTECHNOLOGY: Introduction, Scientific revolutions Time and length scale in structures Definition of a nanosystem, dimensionality and size dependent phenomena Surface to volume ratio Fraction of surface atoms Surface energy and surface stress surface defect Properties at nanoscale (optical, mechanical, electronic, and magnetic).

UNIT – 2 **10 Hours**

DIFFERENT CLASSES OF NANOMATERIALS: Classification based on dimensionality Quantum Dots, Wells and Wires, Carbon based nano materials (buckyballs, nanotubes,

graphene) Metal based nano materials (nanogold, nanosilver and metal oxides) Nano composites NanopolymersNanoglasses Nano ceramics Biological nanomaterial

UNIT – 3 **09 Hours**

SYNTHESIS OF NANOMATERIALS

Chemical Methods: Metal Nanocrystals by Reduction Solvothermal Synthesis Photochemical Synthesis Sonochemical Routes Chemical Vapor Deposition (CVD) Metal Oxide Chemical Vapor Deposition (MOCVD)

Physical Methods: Ball Milling Electrodeposition Spray Pyrolysis Flame Pyrolysis DC/RF Magnetron Sputtering Molecular Beam Epitaxy (MBE).

UNIT – 4 **10 Hours**

Fabrication and characterization of nanostructures: Nanofabrication Photolithography and its limitation Electron beam lithography (EBL) Nanoimprint Softlithography patterning.

Characterization: Field Emission Scanning Electron Microscopy (FESEM) Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) Scanning Tunneling Microscope (STM) Surface enhanced Raman spectroscopy (SERS) ray Photoelectron Spectroscopy (XPS) Auger electrospectroscopy (AES) Rutherford backscattering spectroscopy (RBS).

UNIT -5 **09 Hours**

APPLICATIONS: Solar energy conversion and catalysis Molecular electronics and printed Electronics Nanoelectronics Polymers with a special architecture Liquid crystalline systems Linear and nonlinear optical and electro optical properties, Applications in displays and other devices Nanomaterials for data storage Photonics, Plasmonics Chemical and biosensors Nanomedicine , Nanobiotechnology Nanotoxicology challenges.

ESSENTIAL READINGS:

1. ; T Pradeep "NANO: The Essentials – Understanding Nanoscience and Nanotechnology; Tata McGraw-Hill, India (2007)
2. Richard Booker& Earl Boysen "Nanotechnology",Wiley (2005).

REFERENCE BOOKS

1. Di Ventra"Introduction to Nanoscale Science and Technology [Series: Nanostructure Science and Technology]", et al (Ed); Springer (2004)
2. Linda Williams & Wade Adams"Nanotechnology Demystified", McGraw-Hill (2006)
3. Charles P Poole Jr, Frank J Owens "Introduction to Nanotechnology" , Wiley India Pvt.Ltd., New Delhi, 2008.

COMPOSITE MATERIALS

Sub Code: ME832E4	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course deals with the basics of composite materials and the study of various laminar structure and the fabrication of Metal Matrix composites and its analysis.

Course Objectives:

- An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
- An ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.
- An ability to rotate stress, strain and stiffness tensors using ideas from matrix algebra.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Define Composite materials, manufacturing processes, and applications of composite materials.
CO2: Distinguish between different types of composite materials.
CO3: Analyze problems on macro-mechanical behaviour of lamina in FRP Composites.
CO4: Analyze problems on micro-mechanical behaviour of lamina in FRP Composites.
CO5: Identify the physical , mechanical and wear properties of the Metal matrix composites.

UNIT – 1 **10 Hours**

INTRODUCTION TO COMPOSITE MATERIALS: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites.

APPLICATIONS: Automobile, Aircrafts. missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

FIBER REINFORCED PLASTIC PROCESSING: Lay up and curing, fabricating process, open and closed mould process, hand lay uptechniques;structural laminate bag molding, production procedures for bag molding;filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

UNIT – 2 **09Hours**

MICRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Numerical problems. **Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix.

UNIT – 3 **10 Hours**

MACRO MECHANICS OF A LAMINA Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

BIAXIAL STRENGTH THEORIES: Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problems.

UNIT – 4 **10Hours**

MACRO MECHANICAL ANALYSIS OF LAMINATE: Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) ,Special cases of laminates, Numerical problems

METAL MATRIX COMPOSITES: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application. **FABRICATION PROCESS FOR MMC'S:** Powder metallurgy technique,liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT – 5 **09Hours**

STUDY PROPERTIES OF MMC'S: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.

ESSENTIAL READINGS:

1. K. K. Chawla "Composite Materials: Science and Engineering", Springer, 2012.

2. Autar K. Kaw,"Mechanics of composite materials", Anne books New, Delhi 2006

REFERENCE BOOKS

6. P. K. Mallick"Fiber Reinforced Composites" , 3rd ed. CRC Press - 2014
7. Robert M. Jones"Mechanics of Composite Materials", 2nd ed., Taylor & Francis, 2015
8. MeingSchwaitz"Composite materials hand book," McGraw Hill book company.1984
9. Ronald F. Gibson"Principles of composite Material mechanics" 3rded Taylor & Francis, 2012.
10. MadhujitMukhopadhyay"Mechanics of Composite Materials and Structures", University Press 2009

TRIBOLOGY

Sub Code: ME832E5	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course deals with the study of basics of tribology such a pressure developed in an oil film and about various types of lubrication and the various types of bearings and its design.

Course Objective:

- 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 of tribological surfaces and how to troubleshoot tribology problems.
- Survey tribological testing devices and testing design.

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 behavior of commonly encountered sliding interfaces
CO2: Apply the principles of lubrication to solve engineering problem
CO3: Analyze the effects of friction, wear and lubrication in Metal working process
CO4: Select materials for tribological applications
CO5: Analyze the mechanism of pressure development in oil film
CO6: Find the load carrying capacity of journal bearing

UNIT – 1 **09Hours**

INTRODUCTION TO TRIBIOLOGY: 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.

UNIT – 2 **10 Hours**

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.

UNIT – 3 **09Hours**

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 examples.

UNIT – 4 **09 Hours**

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.

UNIT – 5 **10 Hours**

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.

BEHAVIOR OF TRIBOLOGICAL COMPONENTS: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.

ESSENTIAL READINGS:

1. Basu S K., Sengupta A N., Ahuja B. B., "Fundamentals of Tribiology", PHI, New Delhi, 2012
2. Mujumdar B. C.,"Introduction to TribiologyBearings",S. Chand company pvt. Ltd 2010.

REFERENCE BOOKS:

1. Fuller.D"Theory and Practice of Lubrication for Engineers",New York company 1998
2. Moore"Principles and Applications of Tribiology", Pergamaon press 1998.
3. Srivastava S"Tribiology in Industries", S Chand and Company limited, Delhi 2001
4. Redzimovskay E I"Lubrication of bearings – Theoretical Principles and Design", Oxford press company 2000.

COMPUTER GRAPHICS

Sub Code: ME832E6	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Paper Description: This paper deals with the basic study of the background of the creation of 2D drawing and 3D modelling and the algorithms pertaining to the creation of drawings. It also deals with study of different types of shading and animation done to the models created in the computer.

Paper Objectives:

To Familiarize with

- The concept of the 2D drawing and its algorithms.
- The concept of 3D modelling and its algorithms.
- The functions behind the software packages used in the laboratories.

Learning Outcomes:

- Understand geometric transformation techniques in CAD.
- To describe the hidden concepts ofthe 3d modeling software.
- To describe the various graphical concepts, used to store thepicture.
- Model engineering components using solid modeling techniques.

UNIT – 1 INTRODUCTION AND ALGORITHMS 09 Hours

INTRODUCTION: Workstation, graphics terminal, I/O devices, Line algorithms, 2D and 3D transformations using homogeneous representations, graphics standards.

ALGORITHMS: Text generation, segments, polygon generation and polygon filling.

UNIT – 2 BASIC CONCEPTS AND ADVANCED TREATMENTS 09 Hours

BASIC CONCEPTS: Line, polygon, windowing, clipping and view ports.

ADVANCED TREATMENT: Cubic Splines, Bezier, B-Splines and conic sections.3D modelling concepts, orthographic and perspective projections, problems.

UNIT – 3 VISUAL REALISM 10 Hours

HIDDEN LINE REMOVAL: Model clean up, Hidden line removal algorithm, priority algorithm, area oriented algorithm

HIDDEN SURFACE REMOVAL: Hidden Surface removal, Buffer algorithm and Warnock's algorithm, Hidden solid removal, Biezer Ray Algorithm, improvements of the Larie algorithm.

UNIT – 4 SHADING AND COLOURING 09 Hours

SHADING: Shading, Dyson reflection, specular refection, cavier shading, Gourand and phong shading.

COLOURING: RGB, CMY, HSV and HSL colour models.

UNIT – 5 COMPUTER ANIMATION 10 HoursINTRODUCTION: Introduction, conventional animation, computer animation, animation systems: H/W configuration, S/W architecture and classification, animation types: frame type animation.

TECHNIQUES: Kezfreame techniques, selection algorithm, pair of motion and P-curves, Inbetweening, utilizing moving point constraints, simulation approach and hybrid approach.

TEXT BOOKS

1. Computer Graphics, Van-Dam Foley, 2002.
2. Computer Graphics, Steven Herington, McGraw Hill Book Co. 2001.

REFERENCE BOOKS

1. CAD/CAM Practice, Ibrahim Zeid, TMH. 2001.
2. Mathematical Elements of Computer Graphics, Kogin Adams, 2001.
3. Computer Graphics, Ham and Befer, 2001.
4. SOS Computer Graphics, Plantock – TMH, 2001.

COMPUTATIONAL FLUID DYNAMICS

Sub Code: ME832E7	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: The course will equip the students with the necessary knowledge to use computational techniques to solve problems related to flow mechanics. In particular, students will have hands on experience in using computational fluid dynamics to solve engineering problems. Governing equations, discretisation schemes, numerical methods, turbulence modelling, mesh quality and independence test, numerical errors, and boundary conditions will be introduced in the course

Course Objectives:

The main goal of this course will be to provide the student with a critical view of the main principles, possibilities and limitation of commercial CFD tools for the simulation of incompressible fluid flows. After completion of the course, the student should be able to effectively use a commercial CFD package to solve practical CFD problems, while at the same time be able to provide a critical interpretation of the obtained results

Prerequisite: Thermodynamics, Fluid Mechanics

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: To understand the use of Computational Fluid Dynamics and its solution procedure of pre-process, grid generation and solver.
CO2: To compute the continuity, momentum and energy equations, along with discretization techniques like finite difference method and finite volume method.
CO3: To understand between consistency, stability, convergence, accuracy and distinguish between Generation of structured grids and unstructured grids.
CO4: To apply CFD as a solving tool in field of fluid flow, buoyant free standing fire, flow over vehicle platoon, air/particle flow in human nasal cavity, high speed flows with the help of Advances in computational methods – DNS, LES, RANS-LES coupling for turbulent flows.
CO5: To calibrate and differentiate wind tunnel testing based on design considerations.

UNIT 1 **10 Hours**

INTRODUCTION: Fluid Dynamics, Computational Fluid Dynamics, Advantages, Applications, Future of CFD

CFD SOLUTION PROCEDURE: Problem set up-pre-process, Grid generation, Numerical solution – CFD solver, Result report and visualization-post-process

UNIT 2 **10 Hours**

GOVERNING EQUATIONS FOR CFD: Introduction, the continuity equation, the momentum equation, the energy equation, the additional equations for turbulent flows, generic form of the governing equations for CFD, boundary conditions, well posed and ill posed problems

CFD TECHNIQUES: Introduction, Discretisation of governing equations, Finite difference method, Finite volume method, converting governing equations to algebraic equation system, Numerical solutions, Round off and Discretization errors, Turbulence Models

UNIT 3 **09 Hours**

CFD SOLUTION ANALYSIS: Introduction, consistency, stability, convergence, accuracy, efficiency, case studies

PRACTICAL GUIDELINES FOR CFD: Introduction, grid generation- Structured grids, Body fitted grids, Types and transformations, Generation of structured grids and Unstructured grids, boundary conditions, Independence test, turbulent modeling

UNIT 4 **10 Hours**

APPLICATIONS OF CFD: Introduction, CFD as a design tool, indoor air flow distribution, CFD as a research tool, CFD applied to heat transfer coupled with fluid flow, buoyant free standing fire, flow over vehicle platoon, air/particle flow in human nasal cavity, high speed flows

ADVANCED TECHNIQUES IN CFD: Introduction, advances in numerical methods and techniques – incompressible flows, compressible flows, moving grids, multigrid methods, parallel computing, immersed boundary methods. Advances in computational methods – DNS, LES, RANS-LES coupling for turbulent flows, multiphase flows, combustion, fluid-structure interaction, physiological fluid dynamics and other numerical approaches

UNIT 5 **09 Hours**

INTRODUCTION OF WIND TUNNEL TESTING: Introduction to the purpose of wind tunnel testing - Instrumentation and calibration of the test section. Force, Moment and Pressure measuring devices

TYPES OF WIND TUNNELS: Types of wind tunnels, Wind tunnel design considerations for different types of wind tunnels

TEXT BOOKS

1. Anderson J.D., "Computational Fluid dynamics", Tata McGraw Hill ., New Delhi, 2012
2. Versteeg H.K., and Malalasekera W., "An introduction to computational fluid dynamics", 2nd ed., Pearson, 2008

REFERENCE BOOKS

1. Suhas.V. Patankar "Numerical Heat Transfer and Fluid Flow",Hemisphere Publishing Corporation, 2015
2. Muralidhar.K, and Sundararajan.T "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, Second Edition, 2008
3. Ghoshdasdidar.P.S "Computer simulation of fluid flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998

NON CONVENTIONAL ENERGY RESOURCES

Sub Code: ME832E2	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:1:2	Exam Hours : 03

Course Description: The course discusses the use of solar (thermal and photovoltaic), hydro-electric, wind, geothermal, ocean thermal, wave, tidal and geothermal energy, as well as energy from biomass. The use of fuel-cell systems is dealt with. Issues relevant to energy efficiency and energy storage are discussed. The potential of using renewable energy technologies as a replacement for conventional technologies are discussed. Strategies for enhancing the future use of renewable energy resources are presented

Course Objectives:

The purpose of this course is to impart the importance of the most important renewable energy resources, and the technologies for harnessing these energies

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: To classify and compare the various solar thermal systems like: Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers and solar photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes

CO2: To examine the working of wind, Tidal and wave energy with respect to their types, advantages and disadvantages.

CO3: To describe the concept of thermoelectric system and classify the various biomass and biofuels for Thermo-chemical conversion, direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion and anaerobic digestion.

CO4: To classify and apply the concept of vapour dominated and liquid dominated system in geothermal energy. To describe the MHD open and closed systems.

CO5: To classify and compare the acidic and alkaline hydrogen-oxygen fuel cells, and to explain the Hydrogen production, storage and utilization.

UNIT 1 **10 Hours**

SOLAR ENERGY: Global and National scenarios, Form and characteristics of renewable energy sources, Solar radiation, its measurements and prediction, Solar thermal collectors,

flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems

SOLAR PHOTOVOLTAIC: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes

UNIT 2 **09 Hours**

WIND ENERGY: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristic, applications

TIDAL AND WAVE ENERGY: Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy

UNIT 3 **09 Hours**

THERMOELECTRIC SYSTEMS: Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators

BIOMASS AND BIOFUELS: Biomass resources and their classification, Biomass conversion processes, Thermo-chemical conversion, direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, types of biogas Plants, applications, alcohol production from biomass, bio diesel production, Urban waste to energy conversion-Biomass energy program in India

UNIT 4 **09 Hours**

GEOTHERMAL ENERGY: Introduction, classification of geothermal systems vapour dominated, liquid dominated system, total flow concept, petrothermal systems, magma resources, applications of geothermal operational & environmental problems

MAGNETO HYDRO DYNAMIC POWER GENERATION: Introduction principles of MHD power generation, MHD open and closed systems, power output from MHD generators, design problems of MHD generation, gas conductivity, seeding

UNIT 5 **10 Hours**

ELECTROCHEMICAL EFFECTS AND FUEL CELLS: Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells

HYDROGEN ENERGY: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

TEXT BOOKS

1. Rai.G.D, "Non-Conventional Energy Sources", 4 th edition,Khanna Publishers, New Delhi, 2011

2. Domkundwar.V.M, Domkundwar.A.V, "Solar energy and Non-conventional sources of energy",1st edition, Dhanpat rai & Co. (P) Ltd, New Delhi, 2010

REFERENCE BOOKS

1. S P Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", 2ND EDITION , Tata McGraw Hill, 15TH REPRINT 2006

2. J.A.Duffie and W.A.Beckman, "Solar Engineering of Thermal processes",4TH edition,John Wiley, New York, April 2013

3. Bockris and Srinivasan,"Fuel Cells", Springer; Softcover reprint of hardcover 1st ed. 2006 edition

4. Godfrey Boyle, "Renewable energy", 2nd edition, Oxford University Press, 2010

5. Khan.B, "Non-conventional Sources of energy", 2nd edition, New Delhi, Tata McGraw Hill, 2009

6. Tiwari.G.N, Ghosal.M.K, "Fundamentals of renewable energy sources",1 st edition, UK, Alpha Science International Ltd, 2007

7. Twidell.J.W and Weir.A.D, "Renewable Energy Resources",2nd edition, UK, E.&F.N.Spon Ltd, 2015

OPERATIONS MANAGEMENT

Sub Code: ME832E9	**L:T:P**	**Total Lecture Hrs :47**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: Provides an overview of the functional activities necessary for the creation/delivery of goods and services. Topics covered include: productivity; strategy in a global business environment; project management; quality management; location and layout strategies; human resources management; supply chain and inventory management; material requirements planning; JIT; maintenance and reliability; and other subjects relevant to the field. Required course.

Course Objectives:

- Describe what the operations function is and why it is critical to an organization's survival.
- Describe what a supply chain is and how it relates to a particular organization's operations function.
- Discuss what is meant by operations management and supply chain management.
- Identify some of the major operations and supply chain activities, as well as career opportunities in these areas.
- Make a case for studying both operations management and supply chain management.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: To demonstrate the Business functions and to solve the graphical linear programming method of decision making process.
CO2: To develop the Forecasting process steps and to detect the optimum alternatives for plant capacity and location.
CO3: To assess the aggregate planning strategies and determine a Production Master schedule
CO4: To combine the inventory types and to design an EOQ models.
CO5: To organise the MRP-II and ERP concepts and to plan the Make or buy in production.

UNIT-I **09 Hours**

PRODUCTION AND OPERATIONS MANAGEMENT: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity, contemporary issues and development

DECISION MAKING: The decision process, characteristics of operations decisions, use of models, decision making environments, graphical linear programming, analysis and trade-offs.

UNIT-II **10 Hours**

FORECASTING: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast,

CAPACITY & LOCATION PLANNING: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout – need for layout decisions, types of processing.

UNIT-III **09 Hours**

AGGREGATE PLANNING & MASTER SCHEDULING: Aggregate planning – Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning – graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

UNIT-IV **10 Hours**

INVENTORY MANAGEMENT: Types of Inventories, independent and dependent demand, reasons for holding inventory, objectives of inventory control, requirements for effective inventory management – information, cost, priority system. Inventory control and economic-order-quantity models.

UNIT-V **09 Hours**

MATERIAL REQUIREMENT PLANNING (MRP): Dependent versus independent demand, an overview of MRP – MRP inputs and outputs, MRP processing, An overview of MRP-II and ERP capacity requirement planning, benefits and limitations of MRP.

PURCHASING AND SUPPLY CHAIN MANAGEMENT (SCM): Introduction, Importance of purchasing and SCM, The procurement process, Concept of tenders, Approaches to SCM, Vendor development, Measures of purchasing and SCM, Make or buy decision, Types of buying, E-procurement.

TEXT BOOKS

1 William J Stevenson"Production and Operations Management",8th Edition, Tata McGraw Hill,.

2 B Mahadevan"Operations Management-Theory and Practice", Pearson Education, 2010.

REFERENCE BOOKS

1. Norman Gaither & Greg Frazier"Production and Operations Management".
2. R.B.Chase, N.J.Aquilino, F. Roberts Jacob"Operations Management for Competitive Advantage",Ninth Edition,McGraw Hill Companies Inc.,. 2006
3. Everett E.Adams, Ronald J.Ebert"Production & Operations Management",Prentice Hall of India Publications, 4th Edition.
4. Joseph G Monks,"Production / Operations Management", McGraw Hill Books 1987

SUPPLY CHAIN MANAGEMENT

Sub Code: ME833E1	**L:T:P**	**Total Lecture Hrs :47**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Objectives:

- Understand the scope and practice of business logistics and supply chain management
- Analyze the Business Logistics and Outsourcing Concepts
- Apply the knowledge of Decision Making in industries.
- Discuss about the Role of IT in logistics and supply chain management.
- Relate the concept of Inventory and Warehousing.
- Define the concept of Transportation and Packaging.
- Identify the Organization structure.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: To determine the logistics performance and to compare the make and buy options.

CO2: To discriminate the uncertain risky environment and to infer the optimum decision.

CO3: To develop a warehousing layout, based on cost and space considerations.

CO4: To design an optimized routing for vehicles and to develop a right packaging.

CO5: To devise an organisational structure.

UNIT I INTRODUCTION 09 Hours

Business Logistics: Business logistics and supply chain – importance, objectives and drivers. Strategy – planning, selecting proper channel, performance measurement.

Outsourcing: Outsourcing- Make vs buy approach – sourcing strategy.

UNIT II MANAGING FLOWS 10 Hours

Decision Making: Planning Networks – Decision making under risk – Decision trees – Decision making under uncertainty. Distribution Network Design – Role - Factors Influencing Options, Value Addition..

Role of IT: Supply Chain Network optimization models. Logistics information system - Role of IT – Framework for IT adoption,Application of IOT in Supply Chain Management

UNIT III INVENTORY AND WAREHOUSING 09 Hours

Inventory: Inventory–objectives, bullwhip effect, control - Probabilistic inventory models, Risk pooling, Vendor managed inventory, Multi-echelon inventory.

Warehousing: Warehousing Functions – Types – Site Selection – Decision Model – Layout Design – Costing –Information Flows, Pricing and sourcing

UNIT IV TRANSPORTATION AND PACKAGING 09 Hours

Transportation: Transportation – Drivers, Modes, Measures - Strategies for Transportation, 3PL and 4PL, Vehicle Routing and Scheduling.

Packaging: Packaging- Design considerations, Material and Cost. Packaging as Unitisation.Consumer and Industrial Packaging.

UNIT V ORGANISATION AND CONTROL 10Hours

Organisation: Organisation Structure – need and development. Organizational – Choices, Orientation and positioning. Interfunctional and interorganisational management – alliances and partnerships.

Control: Control – Process framework, system details, information, measurement and interpretation.

ESSENTIAL READINGS:

1. Ronald H. Ballou and Samir K. Srivastava,"Business Logistics and Supply Chain Management", Pearson education,Fifth Edition, 2007; **ISBN:** 9788131705841

2. Sunil Chopra, Peter Meindl,"Supply Chain Management-Strategy, Planning and Operation", Pearson Education, 2016, **ISBN**: 978-0-13-380020-3

RECOMMENDED READINGS:

1. Donald J Bowersox, David J Closs, "Logistics Management – The Integrated Supply Chain Process",Tata McGraw Hill, 2013; **ISBN** : 9780070068834

2. Vinod V. Sople, "Logistics Management-The Supply Chain Imperative", Pearson Education; 2012; **ISBN:** 9788131768624.

3. Coyle, Bardi, Langley, "The Management of Business Logistics: A Supply Chain Perspective", 7th edition;Thompson press; 2013; **ISBN**: 9788131500323.

4. Mohanty R.P and Deshmukh S.G, "Supply chain theories and practices", Biztantra publications, 2008, **ISBN:** 9788177221916.

5. Leenders, Johnson, Flyn, Fearon,"Purchasing and supply management", Tata McGraw Hill, 2013, **ISBN**:978-0072873795.

RAPID PROTOTYPING

Sub Code: ME833E2	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: 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.

Course objectives:

- Describe the current available Rapid Prototyping Systems, their fundamental operating principles, and their characteristics;
- Describe complementary, secondary fabrication processes commonly used with the above Rapid Prototyping Systems; and
- Select the appropriate fabrication technology, or technologies, for a given prototyping task.

Level of Learning: Advanced.

Course Outcomes:

Upon completion of the subject, students will be able to
CO1: Identify the stages of development related to RP system and classification based of material types
CO2: Compare different RP process based on process parameter
CO3: Analyse the different Rapid Tooling process for batch production
CO4: Select and use correct data formats in the manufacture of a 3D printed part
CO5: Analyse suitable orientation workflow for better part fabrication process & reduced part build errors
CO6: Demonstrate the 3-D model using 3-D printer

UNIT - 1 **09 Hours**

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.

UNIT-2 **09 Hours**

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Application, Fusion Deposition ModellingPrinciple, 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.

UNIT-3 **10 Hours**

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, Aluminiumfilled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc.Direct Rapid Tooling Direct. AIM.

UNIT - 4 **09 Hours**

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.

UNIT – 5 **10 Hours**

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 ofbuild orientation.

TEXT BOOKS:

1.Paul F.Jacob"Stereo Lithography and other RP & M Technologies", SME, NY 1996.

2.FlhamD.T&Dinjoy S.S Verlog"Rapid Manufacturing",London2001.

REFERENCE BOOKS:

1.Rapid Prototyping,Terry Wohler's Report 2000"Wohler's Association 2000.

2.Gurumurthi "Rapid Prototyping Materials", IIScBangalore.

3.Lament wood"Rapid Automated", Indus press New York

FLEXIBLE MANUFACTURING SYSTEMS

Sub Code: ME833E3	**L:T:P**	**Total Lecture Hrs :47**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: This course provides the extensive knowledge about the development & implementationFlexible Manufacturing Systems, with their application to various fields. A detail discussion on Material Handling & Storage, Distributed Numerical Control, Tool Management and Group Technology. Flexible Manufacturing Systems provides an overall view about theRelational and Flexible Assembly System..

Course Objectives:

- Explain the concept of group technology, and how it relates to cellular manufacturing.
- Over all view how different types of FMS may be specified.
- Apply knowledge of basic components of an FMS.
- State the five categories of FMS layout.
- Specify the benefits of a successful FMS implementation.
- Outline the Major issues of planning for the creation of FMS.
- Specify the types of quantitative analysis that may be used with regard to FMS.
- Explain the concept of the bottleneck model and the extended bottleneck model.
- State points that arise from FMS quantitative analysis research.

Level of Learning: Advanced.

Course Outcomes:

Upon completion of this course, the students will be able to
CO1:Explain about the overview of FMS its application, configuration and development
CO2:Identify the role of FMS in Automated material handling and storage
CO3:Recall DNC system and tool management of FMS
CO4:Summarise Group Technology and analyse FMS.
CO5:Identify Flexible assembly system and analyse case studies.

UNIT – 1: **10 Hours**

FMS – AN OVERVIEW: Definition of an FMS – Types of flexibility and flexibility criteria in manufacturing, Types & configurations and FMS concepts –FMS applications and benefits.

DEVELOPMENT & IMPLEMENTATION OF AN FMS: Planning phase – Integration – System configuration – FMS layouts – FMS Project development steps.

UNIT – 2: **09 Hours**

AUTOMATED & MATERIAL HANDLING: Functions, Types, Analysis of material handling equipments, Design of Conveyor & AGV systems, Problems.

STORAGE: Storage system performance – AS/RS – Carousel storage system – WIP storage system – interfacing handling storage with manufacturing, Problems 10Hrs

UNIT – 3: **09 Hours**

DISTRIBUTED NUMERICAL CONTROL: DNC system, Communication between DNC computer & machine control unit, Hierarchical processing of data in DNC system – Features of DNC systems.

TOOL MANAGEMENT OF FMS: Tool strategies, tool identification, Tool monitoring and fault detection Wash stations, Inspection stations. CMM, Sequence of operations, Advantages, Types of CMM, Problems.

UNIT – 4: **10 Hours**

GROUP TECHNOLOGY: Part families, Parts classification and coding Production flow analysis, Applications of Group technology, Quantitative analysis in cellular manufacturing, Problems, comparison between cellular manufacturing and FMS.

MODELING AND ANALYSIS OF FMS: Quantitative analysis of Flexible Manufacturing System, problems.Petri net modeling techniques.

UNIT – 5: **09 Hours**

FMS RELATIONAL: Economic and technological justification for Flexible Manufacturing System, typical case studies – Future prospects.

FLEXIBLE ASSEMBLY SYSTEM: Flexible assembly system hardware components and features, design planning and scheduling of FAS

TEXT BOOKS:

1. V Parrish D J, Butter Worth – HeinemannFlexible manufacturing", Ltd Oxford, 1993
2. Groover M P"Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall India (P) Ltd, 2008.
3. Kusiak A"Intelligent Manufacturing Systems", Prentice Hall, Englewood Clitts, NJ, 1990.
4. William W. Luggen"Flexible Manufacturing Cells &Systems",Prentice hall, NJ. 1990

REFERENCE BOOKS:

1. CONSIDINE D M, and CONSIDINE G D, Standard Handbook of Industrial Automation, Chupman and Hall, London, 1986.
2. Viswanatham N &Narahari Y"Performance Modeling of Automated ManufacturingSystems", Prentice Hall of India (P) Ltd, 2009.
3. Ranky P G "The design and Operation of FMS", IFS Pub. Uk, 1988.
4. Dr.H.K.Shivanand "Flexible Manufacturing System",Dhanpat Rai Publications, New Delhi. 2006.

5. Tadeusz Sawik“Production Planning and Scheduling in Flexible Assembly Systems” , springer, 2012.

FRACTURE MECHANICS

Sub Code: ME833E4	**L:T:P**	**Total Lecture Hrs :49**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description:

This course provides the basic knowledge about Fracture Mechanics and their use in modern machine design. A thorough discussion on Failure of material due to crack and various types of cracks are discussed.

Course Objectives:

The course will treat linear and nonlinear fracture mechanics principles and their applications to structural design. Fracture phenomena in metals and nonmetals will be discussed and testing methods will be highlighted. In the end computer assisted techniques for fracture study will be discussed

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Understand material failure for any combination of applied stresses & estimate failure conditions of a structure
CO2: Define the near field equations to determine the stress-strain and loaddisplacement fields around a crack tip
CO3: Identify and formulate stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and non linear materials
CO4: Calculate and predict fracture toughness of materials and be familiar with the experimental methods to determine the fracture toughness
CO5: Analyze the fatigue life of structures using fracture mechanics approach and crack arrest techniques

UNIT – 1 **10 Hours**

FRACTURE MECHANICS PRINCIPLES: Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach.

STRESS ANALYSIS FOR MEMBERS WITH CRACKS: Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. The Dugdale approach, the thickness effect.

UNIT – 2 **10 Hours**

ELASTIC – PLASTIC FRACTURE MECHANICS: Introduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R-curve in fracture mechanics, Experimental determination of J-integral, COD and CTOD.

UNIT -3 **10 Hours**

DYNAMIC AND CRACK ARREST: Introduction, the dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness.

FATIGUE AND FATIGUE CRACK GROWTH RATE: Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws.

UNIT – 4 **09 Hours**

FRACTURE RESISTANCE OF MATERIALS: Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure.

UNIT – 5 **10 Hours**

COMPUTATIONAL FRACTURE MECHANICS: Overview of numerical methods, traditional methods in computational fracture mechanics – stress and displacement marching, elemental crack advance, virtual crack extension, the energy domain integral, finite element implementation. Limitations of numerical fracture analysis.

FRACTURE TOUGHNESS TESTING OF METALS: Specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, NDT methods.

TEXT BOOKS:

1. Karen Hellan"Introduction to Fracture Mechanics" McGraw Hill Pub.1984

2.Jayatilake "Fracture of Engineering Brittle Materials", Applied Science, London. 1979.

REFERENCE BOOKS:

1. T.L. Anderson "Fracture Mechanics – Fundamentals and Application", 3rd ed. Taylor & Francis, 2005.
2. David Broek,"Elementary Engineering Fracture Mechanics" , Springer, New Delhi, 2012 rep.
3. Rolfe and Barsom, "Fracture and Fatigue Control in Structures", Printice Hall 2000.
4. Knott,"Fundamentals of Fracture Mechanics", Bureworth, 2000.

SYNTHESIS OF LINKAGES

Sub Code: ME833E5	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description:

In order to develop the system with motion it is very important to understand all aspect of it. This subject provided deep knowledge of different types of mechanisms and dynamics related to motions. It will also give an opportunity to learn about graphical and analytical methods for dimension synthesis. Moreover, knowledge of different types of sensors, actuators and their application in real world will be explained in vast manner with in the course.

Course Objectives:

Dynamics and mechanism design is an applied science which is used to understand the relationship between the geometry and motions of the parts of mechanism or machine and the forces that produce this motion. The subject therefore includes concepts of linkages, Lagrange's principle. It also provides the knowledge of how to determine displacement, velocity and acceleration as vector. Understanding of force and various concepts of kinetic, potential and mechanical energies are explained.

Learning Outcome:

Analyze and evaluate various types of machines and mechanism and complexity of mordent machines such as new engine, motion of piston and crankshaft.

UNIT – 1 **10 Hours**

PLANAR MECHANISUM AND GEOMETRY OF MOTION: Definitions and basics concepts, Classification of links and pairs, Mechanism and machine, Grashoff's law, Degree of freedom, Equivalent and Unique mechanisms.

NUMBER SYNTHESIS: Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. The Dugdale approach, the thickness effect.

UNIT – 2 **10 Hours**

Synthesis of Linkages: Type, Number and dimensional synthesis, Function generation, Path generation and body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle.

Motion Generation: Poles and relative poles, Relative poles of 4-bar mechanism, Relative poles of slider crank mechanism.

UNIT -3 **10 Hours**

Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point position reduction), Overlay method.

Coupler Curves: Equation of coupler curves, Synthesis for path generation, Graphical synthesis for path generation, Robert-Chebychev theorem (cognate linkages), Coupler curves from 5-bar mechanisms, Examples

UNIT – 4 **09 Hours**

Analytical Methods of Dimensional Synthesis: Fracture Freudenstein's equation for 4-bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis.

UNIT – 5 **09 Hours**

Cams: Introduction, Pressure angle, Parameters affecting pressure angle, Effect of offset follower motion, Radius of curvature and undercutting, Cams with specified contours.

TEXT BOOKS:

1. "Kinematics, Dynamics and Design of Machinery" by K.J.Waldron&G.L.Kinzel, Wiley India,

2007.

2. "Classical Dynamics" by Greenwood Prentice Hall of India, 1988.

REFERENCE BOOKS:

1. "Theory of Machines and Mechanism" by E.Shigley& J.J.Jicker McGraw Hill Company.

2. "Mechanism and Machine Theory" by A.G.Ambekar, PHI, 2007.

3. "Theory of Mechanism and Mechanism" by Ghosh and Mallick, East West press 2007.

4. "Machines and Mechanisms" by David H. Myszka, Pearson Education, 2005.

GAS DYNAMICS AND JETPROPULSION

Sub Code: ME833E6	**L:T:P**	**Total Lecture Hrs :49**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description: Gas dynamics is the field of study associated with the forces and motion of gasses. It is a subset of the general field of fluid dynamics that considers liquids in addition to gasses. Many fluids can be considered incompressible. This provides a degree of simplification to the equations that govern the motion of the fluid. A gas is compressible and the coupling between the fluid properties such as density, pressure, and temperature creates a close link between gas dynamics and thermodynamics. Choked flow and shock waves are two phenomena that are encountered with gases that are not generally encountered with liquids. These phenomena are directly related to compressibility effects. The second part of the course deals with rocket propulsion and imparts a basic knowledge on different space propulsion techniques

Course Objectives:

- Introduce the fundamentals of compressible fluid flow, with an emphasis on a wide variety of steady, one-dimensional flow problems and a general understanding of the principles of expansion waves
- Provide the fundamentals of rocket propulsion, with an emphasis on understanding different means of propulsion

Course Outcomes:

Upon completion of the course, students will be able to

CO1: Formulate and solve problems in one -dimensional steady compressible flow including: isentropic nozzle flow, constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayleigh flow)
CO2: Derive the conditions for the change in pressure, density and temperature for flow through a normal shock
CO3: Determine the strength of oblique shock waves on wedge shaped bodies and concave corners
CO4: Determine the change in flow conditions through a Prandtl-Meyer expansion wave explain the measurement techniques for compressible flow
CO5: Demonstrate an understanding of fundamentals of chemical rocket performance; how liquid and solid propellant rockets work

Prerequisite: Basic Thermodynamics, Fluid Mechanics

UNIT 1 **10 Hours**

BASIC CONCEPTS: Introductory Concepts to Compressible Flow- Concept of continuum system and control volume approach- conservation of mass, momentum and energy- stagnation state- compressibility- Mach number- Effect of Mach number on compressibility-

Pressure coefficient-Physical difference between incompressible, subsonic and supersonic flows - Mach cone

ISENTROPIC FLOWS: One dimensional steady isentropic flow- Adiabatic and isentropic flow of a perfect gas- basic equations- Area-Velocity relation using 1D approximation nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser- working tables-charts and tables for isentropic flow

UNIT 2 **10 Hours**

FLOW IN A CONSTANT AREA DUCT WITH FRICTION (FANNO FLOW): Governing Equations- Fanno line on h-s and P-v diagram- Fanno relation for a perfect gas- Chocking due to friction- Simple numerical

FLOW THROUGH CONSTANT AREA DUCT WITH HEAT TRANSFER (RAYLEIGH FLOW): Governing equations- Rayleigh line in h-s and P-v diagram-Rayleigh relation for perfect gas- Simple numerical

UNIT 310 Hours NORMAL AND OBLIQUE SHOCKS: Governing equations, Variation of flow parameters across the normal and oblique shocks, Prandtl – Meyer relations, Use of table and charts, Applications, Simple numerical

COMPRESSIBLE FLOW FIELD VISUALIZATION AND MEASUREMENT: Shadowgraph, Schlieren technique, interferometer, subsonic compressible flow field measurement (Pressure, Velocity and Temperature), compressibility correction factor, hot wire anemometer, supersonic flow measurement, Rayleigh Pitot tube, wedge probe, stagnation temperature, probe- temperature

UNIT 410 Hours

FUNDAMENTALS OF ROCKET PROPULSION: Operating principle, Specific impulse of a rocket, internal ballistics, Rocket nozzle classification, Rocket performance considerations

SOLID PROPELLANT ROCKET: Solid propellant rockets, Selection criteria of solid propellants, Important hardware components of solid rockets, Propellant grain design considerations

UNIT 5 **09 Hours**

LIQUID PROPELLANT ROCKET: Liquid propellant rockets, Selection of liquid propellants, Cooling in liquid rockets, Hybrid rockets

ADVANCED PROPULSION TECHNIQUES: Electric rocket propulsion, Ion propulsion techniques, Nuclear rocket, Types, Solar sail, Preliminary Concepts in nozzleless propulsion

TEXT BOOKS

5. Anderson, J.D Jr."Modern Compressible Flows", Tata McGraw Hill, 2017.
6. Yahya.S.M, "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd, New Delhi, 2017.
7. Radhakrishnan.E, "Gas Dynamics", PHI Learning Pvt. Ltd, 6th edition, 2017.
8. Zucrow, M., Gas Dynamics, Wiley India, 2013

DATA BOOK

2. Yahya.S.M, "Gas Tables for compressible flow calculations", New Age International (P) Ltd, New Delhi, 6th edition, 2011

REFERENCE BOOKS

4. Mattingly.J.D, "Elements of Propulsion: Gas turbines and Rockets", McGraw Hill, 2012
5. Balachandran.P, "Fundamentals of compressible fluid dynamics", PHI Learning, 2012
6. Robert.D.Zucker, "Oscar Biblarz, Fundamentals of Gas Dynamics"2nd edition, John Wiley and Sons, , 2011

ENERGY ENGINEERING

Sub Code: ME833E7	**L:T:P**	**Total Lecture Hrs :46**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description:

This course reviews the relation between energy usage and quality of life, the social impact of energy use, and the environmental constraints. In particular, the role that engineering disciplines play in solving energy problems will be discussed. The full impact that the various energy alternatives have on economic and environmental issues will be reviewed to provide a rational basis for energy choices for the future

Course Objectives:

The objective of the course is to familiarize the students about the utilization of various alternative sources of energy technologies for thermal and electrical needs with environmental merits

Prerequisite:*Basics*

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Compare the types of fuels used in a power plant based their advantages and disadvantages
CO2: Design of chimney by calculating the height of chimney to produce a draft pressure and design of layout of a diesel power plant based on capacity.
CO3: Compare the advantages and disadvantages hydel and nuclear power plant.
CO4: Compare the advantages and disadvantages of wind, solar and tidal energy.
CO5: Describe the working of fuel cell, geothermal and bio-mass energy to understand the scope for each.

UNIT 1 **09 Hours**

Steam Power Plant: Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners

Pulverized Coal And Furnace: Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures

UNIT 2 **09 Hours**

Steam Generators: Chimneys - Natural, forced, induced and balanced draft, Calculations and numericals involving height of chimney to produce a given draft. Cooling towers and

Ponds, Accessories for the Steam generators such as Superheaters, Desuperheater, control of superheaters, Economizers, Air pre-heaters and re-heaters

Diesel Engine Power Plant: Applications of Diesel Engines in Power field, Method of starting Diesel engines, Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant

UNIT 3 **10 Hours**

Hydro-Electric Plants: Hydrographs, flow duration and mass curves, unit hydrograph and numericals. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves, General layout of hydel power plants

Nuclear Power Plant: Principles of release of nuclear energy; Fusion and fission reactions, Nuclear fuels used in the reactors, Multiplication and thermal utilization factors, Elements of the nuclear reactor; moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types - Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shieldings, Radio-active waste disposal

UNIT 4 **09 Hours**

Solar Energy: Solar Extra-terrestrial radiation and radiation at the earth surface, radiation-measuring instruments, working principles of solar flat plate collectors, solar pond and photovoltaic conversion (Numerical Examples)

Wind and Tidal Power:

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations

UNIT 5 **09 Hours**

OTEC, Geothermal Energy and Biomass: OTEC:Principle of working, Rankine cycle. Geothermal Energy Conversion:Principle of working, types of geothermal station with schematic diagram. Biomass: Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - pyrolysis, gasification, combustion and fermentation, Gasifiers, Digesters, economics of biomass power generation

Direct Energy Conversion Systems: Basic principle of Thermo-electric and Thermo-ionic power generations, Fuel cell - principle, types, applications, Magneto hydrodynamic power generation - Principle, open cycle and closed cycles, Hydrogen energy - Production, storage, and applications

TEXT BOOKS

3. P. K. Nag"Power Plant Engineering", Tata McGraw Hill, 4th ed. edn 2014
4. Domakundawar"Power Plant Engineering", Dhanpath Rai sons. 2015

REFERENCE BOOKS

5. R. K. Rajput "Power Plant Engineering", Laxmi publication, New Delhi
6. A. W. Culp Jr. "Principles of Energy conversion", McGraw Hill. 1996
7. G D Rai, "Non-conventional Energy sources", Khanna Publishers
8. B H Khan "Non-conventional resources", TMH - 2009

ADVANCED AUTOMOTIVE ENGINEERING

Sub Code: ME833E8	**L:T:P**	**Total Lecture Hrs :48**
Exam Marks: 100	**Hrs/week : 3:0:0**	**Exam Hours : 03**

Course Description:

Automotive engineering is a branch of mechanical engineering that concerns the design, development and manufacture of cars, trucks, motorcycles and other motor vehicles. It also deals with design and test of many subsystems or components that comprise a motorized vehicle

Course Objective:

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

Prerequisite: Basicknowledge on IC engines

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: To describe chassis, body and engine components of automobile
CO2:To demonstrate knowledge of clutch and gear box
CO3:To demonstrate knowledge of engine injection and ignition systems
CO4: To demonstrate knowledge of steering, brakes and suspension systems
CO5:To demonstrate knowledge on advanced features of automobile and x by wire technology
CO6: To describe environmental impact of emissions from vehicles and methods for controlling it

UNIT 1 **09 Hours**

Chassis and frames: Automobile history and development, Chassis, frames, articulated and rigid vehicles and vehicles layout, Prime movers

Engine construction: Structural components and materials, Fuel supply system, cooling and lubrication systems, Filters, water pumps, radiators, Thermostats, antifreezing Compounds

UNIT 2 **10 Hours**

Clutch: Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single & multi plate clutch, fluid Clutch.

Gear box: Necessity of transmission, principle, types of transmission, Sliding mesh, constant mesh, synchromesh, Transfer gear box, Gear Selector mechanism, lubrication and control, Torque Converter, Automatic Transmission

UNIT 3 **09 Hours**

Transmission system and Differential: 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

UNIT 4 **10 Hours**

Steering, Tyres and suspension systems: 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 of fully 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

UNIT 5 **10 Hours**

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

X-By Wire Technology: What is X-By Wire, Advantage over hydraulic systems, Use of Automotive micro controllers, Types of sensors, Use of actuators in an automobile environment

TEXT BOOKS:

1. Crouse, W.H., and Anglin, D.L"Automotive Mechanics", Tata McGraw Hill, New Delhi, 2009
2. Heitner, J"Automotive Mechanics", CBS Publisher, New Delhi, 2006

REFERENCE BOOKS:

1. Narang, G.B., "Automobile Engineering", Khanna Publishers, New Delhi, 2015
2. Kamaraju Ramakrishna "Automobile Engineering", , PHI Learning pvt. Ltd., New delhi, 2012
3. Heinz Heisler "Advanced Vehicle Technologies"-SAE International Publication, 2002
4. Ronald K. Jurgen "Electric and Hybrid Electric vehicles".- SAE International Publication
5. "Electronic Braking, Traction and Stability control"-SAE Hardbound papers, 2006
6. "Electronics steering and suspension systems"- SAE Hardbound papers 1999.

INTERNET OF THINGS

Sub Code: ME833E9	L:T:P	Total Lecture Hrs :50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Objective:

- To understand the Vision and scope of IoT.
- To understand IoT Market perspective.
- To understand the various components of IoT.
- To Understand State of the Art – IoT Architecture.
- To demonstrate knowledge on Real World IoT Design.

CourseOutcomes:

Upon completion of the course, the students will be able to

CO1: Understand the vision and scope of IoT from a global context.
CO2:Explain the Market perspective of IoT.
CO3: Demonstrate the use of Devices, Gateways and Data Management in IoT.
CO4:Design state of the art architecture in IoT.
CO5:Design real world IoT solutions.

UNIT I

M2M to IoT10 Hours

The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

UNIT II

M2M to IoT – A Market Perspective&An Architectural Overview 10 Hours

A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. **An Architectural Overview–** Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT III

M2M and IoT Technology Fundamentals10 Hours

Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT IV

IoT Architecture-State of the Art10 Hours

Introduction, State of the art, **Architecture Reference Model-** Introduction, Reference Model and architecture, IoT reference Model

UNIT V

IoT Implementation **10 Hours**

IoT Reference Architecture -Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. **Real-World Design Constraints-** Introduction, Technical Design constraints-Hardware, Data representation and visualization, Interaction and remote control. **Industrial Automation-** Service-oriented architecture-based device integration, realizing the enterprise integrated Web of Things, from the Web of Things to the Cloud of Things.

TEXT BOOKS:

- Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, **"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",** 1st Edition, Academic Press, 2014.

REFERENCE BOOKS:

- Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
- Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013

OPEN ELECTIVES

GREEN BELT PRACTICE

Sub Code: ME63OE01	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description:
This course provides a working knowledge of the varied aspects of Six Sigma, Lean and Process Control initiatives, while preparing Green Belts for advanced studies in more specialized topics within the subject area. Green Belts will increase their knowledge and use of improvement tools.

Course Objective:
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

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: Understand the concepts of quality control, improvement and management.
CO2: Understand and apply different tools & techniques of quality engineering and management.
CO3: Understand the concept of design for quality.
CO4: Understand and apply the concept and importance of service quality.
CO5: Understand quality management standards.
CO6: Understand the latest quality improvement methodology, that is, Six Sigma.

UNIT-I **10 Hours**
INTRODUCTION: Different Definitions and Dimensions of Quality, Historical Perspective(From Evolution of Quality Control, Assurance and Management toQuality as Business Winning Strategy), Contribution of Renowned QualityGurus (Their Philosophies and Impact on Quality).

UNIT-II **10 Hours**
QUALITY ENGINEERING AND MANAGEMENT TOOLS, TECHNIQUES & STANDARDS:(A) Statistical Quality Control: Causes of Variation, Control Chartsfor Variables (Mean and Range, Mean and Standard Deviation,Cumulative Sum Control Chart), Control Chart Patterns and
Corrective Actions, Control Charts for Attributes (p-chart, npchart,c-chart, u-chart), Acceptance Sampling Plans (Concepts ofProducer's and Consumer's Risks, Types of Sampling Plans andtheir merits and demerits, Operating Characteristic Curve,Average Outgoing Quality Curve), Errors in Making Inferencesfrom Control Charts (Type I and II errors).

UNIT-III **10 Hours**

QUALITY ENGINEERING AND MANAGEMENT TOOLS, TECHNIQUES & STANDARDS:(B) Quality Control & Improvement Tools: 7 QC tools, 7 NewQuality 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)

UNIT-IV **10 Hours**

DESIGNING FOR QUALITY: Introduction to Concurrent Engineering, QualityFunction Deployment (QFD) and Failure Mode and Effect Analysis(FMEA) – Concept, Methodology and Application.

Quality in Service Sectors: Characteristics of Service Sectors, QualityDimensions in Service Sectors, Measuring Quality in Different ServiceSectors.

UNIT-V **10 Hours**

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.

TEXT BOOKS

1. Amitava Mitra "Fundamentals of Quality Control and Improvement", Prentice – Hall International Edition.
2. Frank M. Gryna, Richard C. H. "Juran's Quality Planning & Analysis for Enterprise Quality",Tata McGraw Hill Edition.
3. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre "Total Quality Management", Pearson Educaiton.
4. Craig W. Baird "The Six Sigma Manual for Small and Medium Businesses", Yes Dee Publishing Pvt. Ltd.
5. N. Logothetis "Managing for Total Quality", Prentice Hall of India Pvt. Ltd.

REFERENCE BOOK

1. Eugene L. Grant and Richard S. Leavenworth "Statistical Quality Control", Tata McGrawHill Publishing Company Ltd.
2. B. L. Hanson & P. M. Ghare "Quality Control & Application", Prentice Hall of India
3. J. M. Juran & F. M. Gryna "Quality Control Handbook", Prentice Hall Publications.
4. K C Arora "Total Quality Management", S K Kataria & Sons.
5. Dr. S. Kumar "Total Quality Management", Laxmi Publication Pvt. Ltd.
6. Warren Brussee "All About Six Sigma", Tata McGraw Hill Edition

FACILITY PLANNING AND DESIGN

Sub Code: ME63OE02	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Basic study of facilities planning, design, financing, safety, and maintenance issues important in the development of sport, recreation, and fitness indoor and outdoor facilities.

Course Objective:

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.

Course Outcomes:

Upon completion of this course, the students will be able to

CO1: Understand the factors influencing decisions related to plant location, layout and Material Handling Systems.

CO2: Recognize the influences of product and process design as well as analyse their effects on the facility layout design problems.

CO3: Develop systematic facility layout plans using mathematical models and algorithmic approaches.

CO4: Evaluate alternative facilities planning and design solutions.

CO5: Create an integrated facilities plan for various applications

UNIT-I **10 Hours**

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.

UNIT-II **10 Hours**

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

UNIT-III **10 Hours**

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.

UNIT-IV **10 Hours**

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.

UNIT-V **10 Hours**

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

REFERENCE BOOKS

1. James A Tompkins, John A. White, Yavuz A. Bozer, "Facilities Planning", 3rdEdition, Wiley India, ISBN- 978-81-265-1781-7, 2009.

2. James M Apple, "Plant Layout and Material Handling", 3rd Edition ,Krieger Pub Co., , ISBN-13: 978-0894645457, January 1991.

3. Francies R.L. and White J.A. "Facility layout and Location", Prentice Hall of India, 2nd Edition, ISBN: 8120314603, 1998.

4. Sunderesh Heragu, "Facilities Design", PWS Publishing Company, 4th Edition, ISBN-0-595 359388, 2006.

BASIC AUTOMOBILE ENGINEERING

Sub Code: ME63OE03	L:T:P	Total Lecture Hrs :48
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Automotive engineering is a branch of mechanical engineering that concerns the design, development and manufacture of cars, trucks, motorcycles and other motor vehicles. It also deals with design and test of many subsystems or components that comprise a motorized vehicle

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

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: To describe chassis, body and engine components of automobile
CO2: To demonstrate knowledge of transmission, cooling and lubrication systems
CO3: To demonstrate knowledge of engine injection and ignition systems
CO4: To demonstrate knowledge of steering, brakes and suspension systems
CO5: To describe environmental impact of emissions from vehicles and methods for controlling it.

UNIT 1 **10Hours**

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

UNIT 2 **09Hours**

Fuel Supply Systems: Petrol and diesel engines, fuel pumps, Mechanical and electrical diaphragm pumps, air and fuel filters
Carburetors and Injection System: carburetors, fuel injection systems for diesel and petrol engines, electronic fuel injection, super chargers, mufflers

UNIT 3 **09Hours**

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

UNIT 4 **10Hours**

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

UNIT 5 **10Hours**

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

TEXT BOOKS:

1. Kripal Singh,"Automobile Engineering", Vol.-1 & 2, Standard publisher distributors 2015.
2. Joseph Heitner,"Automotive Mechanics", East-West student edition 2014.

References:

1. Crouse. W.H. and Angling, D.L "Automobile Mechanics"2009.
2. Judge, A.W ,"Automobile Electrical System"
3. K.k.Ramalingam,"Automobile engineering", scitech publications 2001

PROJECT MANAGEMENT

Sub Code: ME63OE04	L:T:P	Total Lecture Hrs :47
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: The purpose of this course is to lay the foundation for a solid understanding of project management concepts and principles and to familiarize students with the complexity and challenge of managing public or private projects with tight schedules and limited resources. Students will gain a sound understanding of project management concepts and principles by applying relevant tools and techniques and by making extensive use of case studies and simulation exercises to assimilate that knowledge

Course Objectives: 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

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Apply the concept of project management in engineering field through project management life cycle
CO2: Analyze the quality management and project activity in engineering field through work breakdown structure.
CO3: Analyze the fundamentals of project and network diagram in engineering and management domain through PDM techniques.
CO4: Evaluate the concept of network analysis through PERT and CPM techniques
CO5: Apply the concept of schedular based on resource avaibability in engineering and management field through project proposal

Prerequisite: Nil

UNIT 1 **09 Hours**

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

UNIT 2 **09 Hours**

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

UNIT 3 **09 Hours**

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, Analyzing the Initial Project Network Diagram.

UNIT 4 **10 Hours**

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 leveling and Resource allocation

Unit 5 **09 Hours**

Schedules Based on Resource Availability: Resources, Leveling Resources, Acceptability Leveled Schedule, Resource Leveling Strategies, Work Packages: Purpose of a Work Package, Format of a Work Package

Joint Project Planning Session: Planning the Sessions, Attendees, Facilities, Equipments, Complete Planning Agenda, Deliverables, Project Proposal

TEXT BOOKS:

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

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

REFERENCE BOOKS

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

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

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

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

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

BASIC AEROSPACE ENGINEERING

Sub Code: ME63OE05	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This first part of the course "Basic Aeronautical Engineering" presents an overall picture of the aeronautics domain. This overview involves a number of different perspectives on the aerospace domain, and shows some basic principles of the most important concepts for flight. Then the basic aerodynamics are covered, followed by flight mechanics

Course Objectives:

- 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

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: To explain flow regimes (viscous/non-viscous; compressible/incompressible aerodynamics) and to estimate viscous and thermal effects

CO2: To compute lift/drag of simple aero foil configurations

CO3: To describe reference frames and derive general equations of motion for flight and orbital mechanics

CO4: To apply equations of motion to determine aircraft performance in steady gliding, horizontal and climbing flight

CO5: To derive aircraft performance diagram and flight envelope, in relation to aircraft morphology, lift-drag polar and engine performance

UNIT 1 **10Hours**

Aircraft Configurations: Brief History- airplanes and Helicopters – Components of an airplane and their functions. Different types of flightvehicles, classifications, Basic instruments for flying
Introduction to Principles of Flight: Physical properties and structure of the atmosphere, Temperature, pressure and altituderelationships, Evolution of lift, drag and moment, different types of drag

UNIT 2 **10Hours**

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

UNIT 3 **09 Hours**

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

UNIT 4 **10Hours**

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

UNIT 5 **10Hours**

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

TEXT BOOKS

1. Kermode,A.C., 'Flight without Formulae', Pearson,2004

2. Shevell,R.S., Fundamentals of flights, Pearson education 2004

REFERENCE BOOKS

1. Anderson.J.D., Introduction to Flight, McGraw Hill,2010

2. McKinley.J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill1993

3. Pallet.E.H.J. Aircraft Instruments & Principles, Pearson 2010

INDUSTRIAL ROBOTOICS

Sub Code: ME63OE06	L:T:P	Total Lecture Hrs :49
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: To impart knowledge about the engineering aspects of Robots and theirapplications

Course Objectives:

- 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

Course Outcomes:

Upon completion of this course, the students will be able to
CO1: Explain the basic components of robots
CO2: Differentiate types of robots, sensors and robot grippers
CO3: Compare forward and inverse kinematics of robot manipulators
CO4: Programme a robot to perform tasks in industrial applications
CO5: Design robot cell considering robot safety and its control
CO6: Summarize industrial applications and Recent developments in Robotics

UNIT 1 **10Hours**

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

UNIT 2 **10Hours**

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 digitizin, Image processing and analysis

UNIT 3 **10Hours**

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

UNIT 4 **10Hours**

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

UNIT 5 **09Hours**

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

TEXT BOOKS

1. Deb .S.R, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, New Delhi, 2010

2. Mikell P. Groover, "Industrial Robotics Technology Programming and

Applications", McGraw Hill Co., Singapore, 2009

REFERENCE BOOKS

1. Klafter.R.D, Chmielewski.T.A and Noggins, "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd., New Delhi, 2009.

2. Fu K.S, Gonzalez.R.C,& Lee, C.S.G, "Robotics control, sensing, vision and intelligence", McGraw Hill Book Co., Singapore, Digitized 2010

3. Craig.J.J, "Introduction to Robotics mechanics and control", Addison, Wesley, London, 2009.

NON-DESTRUCTIVE TESTING

Sub Code: ME63OE07	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: Non-destructive Testing (NDT) plays an extremely important role in quality control, flaw detection and structural health monitoring covering a wide range of industries. There are varieties of NDT techniques in use. This course will first cover the fundamental science behind the commonly used NDT methods to build the basic understanding on the underlying principles. It will then go on to cover the process details of each of these NDT methods.

Course Objective:
NDT techniques are used for locating flaws as well as for characterizing material properties. Flaws within the materials canplay 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.

Course Outcomes:
Upon successful completion of this course, students should be able to:
CO1: Acquire the knowledge in the field of non-destructive testing and detect defects using NDT methods
CO2: Identify, recognize and select the necessary testing methods to inspect the parts
CO3: Evaluate and advise on the possibilities and limitations of a testing method
CO4: Describe, evaluate, monitor and improve the manufacturing processes
CO5: Understand Probability of Detection Concepts in Non-Destructive Testing
CO6: Know Codes, Standards, Specification and Procedures in non-destructive testing

UNIT -I **10 Hours**
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.

UNIT-II **10 Hours**
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.

UNIT-III **10 Hours**
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 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-IV **10 Hours**

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, Leak Testing Methods, Leak Detection, Bubble testing, Helium leak detector, Standards.

UNIT-V **10Hours**

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 NON-DESTRUCTIVE TESTING: 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.

TEXT BOOKS

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

REFERENCES

1. Prasad J, "Non-destructive Test & Evaluation of Materials", Tata McGraw-Hill, New Delhi, 2008.
2. Boyer, H.E, and T.L.Gall, "Metals Hand Book", American Society for Metals, 1988.

ENERGY AND ENVIRONMENT

Sub Code: ME63OE08	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: The main objectives of this course are to: provide basic understanding and appreciation of energy and environmental concepts and interconnectedness; analyse energy consumption patterns; discuss various energy resources that power the modern society; examine the energy conversion processes; explore interrelationships between energy use and industrial progress and environmental consequences; discuss future energy alternatives.

Course Objectives:
1. Understand energy scenario, energy sources and their utilization
2. Learn about methods of energy storage, energy management and economic analysis
3. Have proper awareness about environment and eco system.
4. Understand the environment pollution along with social issues and acts.

Course Outcomes:
Upon completion of this course, the students will be able to
CO1: Summarize the basic concepts of energy, its distribution and general Scenario.
CO2: Explain different energy storage systems, energy management, audit and economicanalysis.
CO3: Summarize the environment eco system and its need for awareness.
CO4: Identify the various types of environment pollution and their effects.
CO5: Discuss the social issues of the environment with associated acts.

UNIT-I **10 Hours**
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'senergy development: Economy and demographics Policy and institutional framework, Energyprices and affordability, Social and environmental aspects, Investment.

UNIT-II **10 Hours**
ENERGY STORAGE SYSTEMS: Thermal energy storage methods, Energy saving, Thermal energy storage systems. Energy Management: Principles of Energy Management, Energy demand estimation, Energypricing.
ENERGY AUDIT: Purpose, Methodology with respect to process Industries, Characteristic methodemployed in Certain Energy Intensive Industries. Economic Analysis: Scope, Characterization of an Investment Project.

UNIT-III **10 Hours**
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, foodwebs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem andAquatic ecosystems, Ecological succession.

UNIT-IV **10 Hours**

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 inprevention of pollution, Pollution case studies.

UNIT-V **10 Hours**

SOCIAL ISSUES AND THE ENVIRONMENT: Climate change, global warming, acid rain, ozone layerdepletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, consumerismand waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act,Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest ConservationAct, Issues involved in enforcement of environmental legislation.

TEXT BOOKS

1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute ofenvironment education and Research, Pune
2. De, B. K., "Energy Management audit & Conservation", 2nd Edition, Vrinda Publication, 2010.

REFERENCE BOOKS

1. Turner, W. C., Doty, S. and Truner, W. C., "Energy Management Hand book", 7th edition, Fairmont Press, 2009.
2. Murphy, W. R., "Energy Management", Elsevier, 2007.
3. Smith, C. B., "Energy Management Principles", Pergamum, 2007
4. C S rao "Environment pollution control Engineering" 2nd edition, New Age Inytermnational, 2006, reprint 2015.
5. Benny Joseph "Environmental studies", Tata McGraw Hill, 2008, 2nd edition.

E- LEARNING

1. India Energy Outlook 2015(www.iea.org/.../IndiaEnergyOutlook_WEO2015.pdf)
2. Open courseware

ALTERNATE ENERGY SOURCES FOR AUTOMOBILES

Sub Code: ME63OE09	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description:
One of the most pressing issues of modern times is how we will satisfy our future energy needs and what influence this might have on global warming. This course pursues developing intuitive insights into the benefits and limitations of various approaches to energy generation, and how to differentiate between hype, scientific analysis, and political interference. This course will provide a strong foundation for anyone interested in pursuing energy studies and their connection to environmental impact and human nature.The course will examine the advances made since the advent of the steam engine by people who increasingly exploited energy sources to do work for them, especially in manufacturing and transportation.

Course Objectives:
The objectives of this course is to
1. Describe need for alternative fuels for internal combustion engine and alternative drive systems for automobiles
2. Describe principle of solar energy collection, construction of photo voltaic cells
3. Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
4. Explain use of hydrogen for internal combustion engine application.
5. Describe use of various gaseous fuels for internal combustion engine application.
6. Understand various aspects of electrical and Hybrid vehicles

Course Outcomes:
Upon completion of above course, students will be able to
CO1: Describe need for alternative fuels for internal combustion engine and alternative drivesystems for automobiles
CO2: Describe principle of solar energy collection, construction of photo voltaic cells
CO3: Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
CO4: Explain use of hydrogen for internal combustion engine application.
CO5: Describe use of various gaseous fuels for internal combustion engine application.
CO6: Explain various aspects of electrical and Hybrid vehicles

UNIT-I **10 Hours**
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. Fuelquality aspects related to emissions. Technological up gradation requiredbusiness driving factors for alternative fuels. Implementation barriers foralternative fuels. Stakeholders of alternative fuels,roadmap for alternative fuels.
SOLAR ENERGY: Solar energy geometry, solar radiation measurement devices. Solar energycollectors, types of collectors. Direct application of solar energy, solar energystorage system. P. V. effect solar cells and characteristics. Application of solarenergy for automobiles.

UNIT-II **10 Hours**

BIOGAS:History, properties and production of Biogas, classification of biogas plants,biogas storage and dispensing system. Advantages of biogas, hazards andemissions of biogas. Production, properties, Engine performance, advantagesand disadvantages of Methanol, Ethanol, Butanol, Straight vegetable oil,Biodiesel for internal combustion engine application.

UNIT-III **10 Hours**

HYDROGEN: Properties and production of hydrogen, Storage, Advantages anddisadvantages of hydrogen, use of Hydrogen in SI and CI engines. Hazardsand safety systems for hydrogen, hydrogen combustion. Emission fromhydrogen.

GASEOUS FUELS: Production, properties, Engine performance, advantages and disadvantages ofCNG, LNG, ANG, LPG and LFG.

UNIT-IV **10 Hours**

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 ofPMF, Ammonia, Liquid-Nitrogen, Boron, Compressed Air, Water as fuel forinternal combustion Engine.

UNIT-V **10 Hours**

ALTERNATIVE POWER TRAINS: Components of an EV, EV batteries, chargers, drives, transmission and powerdevices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEVdrive train components, advantages of HV. History of dual fuel technology,Applications of DFT. Duel fuel engine operation. Advantages anddisadvantages of duel fuel technology.

TEXT BOOKS:

1. S .S. Thipse "Alternative Fuels". JAICO Publishing House.
2. G. D. Rai "Non-Conventional Energy Sources", Khanna Publishing New Delhi

REFERENCE BOOKS:

1. M. Poulton "Alternative fuels for Vehicle"
2. R. Bechtold "Alternative fuels guide".SAE
3. T.N Veziroglu "Alternative energy sources ", McGraw Hill
4. A Primer on Hybrid Electric vehicles
5. Richard L. Bechtold "Automotive Fuels Guide", SAE Publications, 1997

ADVANCED MANFACTURING TECHNOLOGY

Sub Code: ME63OE10	L:T:P	Total Lecture Hrs : 50
Exam Marks: 100	Hrs/week : 3:0:0	Exam Hours : 03

Course Description: This course provides the basic knowledge about manufacturing techniques, selection of suitable machine and a cutting tool for a specific application. A thorough discussion on machine tools involving mechanism and principle of working are explained elaborately with the help of merchant circle diagram. The concept of casting and welding are also included to understand the possibility of a process in a certain direction.

Course Objectives:
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….

Course Outcomes:
Upon completion of above course, students will be able to
CO1: Classify the manufacturing process and identify the basic requirements of the casting process.
CO2: Understand various parts and machining operations on lathe
CO3: Understand the constructional features and working operations of drilling, shaping, milling and grinding
CO4: Analyse the programming of NC/CNC with the advantages and disadvantages
CO5: To understand the need of rapid prototyping and classify the different systems in rapid prototyping.

UNIT-I **10 Hours**
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.

UNIT-II **10 Hours**
PRIMARYMANUFACTURING: 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.

UNIT-III **10 Hours**
DRILING AND MILLING:Classification, constructional features of upright, multiple spindle, deep hole & automatic drilling machine. Classification, constructional 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 grinding wheels, grinding wheel types. Constructional features of a Shaper.

CAPSTUN TURRET AND SPM: Classification, constructional features, Tool Layout of Turret & Capstan Lathe and SPM

UNIT-IV **10 Hours**

CNC MACHNING: 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.

UNIT-V **10 Hours**

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.

TEXT BOOKS

1. Stereo Lithography and other RP & M Technologies,Paul F.Jacob s: SME, NY 1996.
2. Production Technology: Manufacturing Processes, Technology and Automation 17th Edition" by R K Jain, Khanna Publishers, 2012.

REFERENCE BOOKS

1. Manufacturing Engineering and Technology , Steven R Schmid , Serope Kalpakjian, Pearson publication, 2014.
2. "Manufacturing Technology: Foundry, Forming and Welding", 4e (Volume 1) [Kindle Edition], McGraw Hill (14 May 2013), ASIN: B00H1Q21EO.