DEPARTMENT OF MECHANICAL ENGINEERING

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

PERIYAR MANIAMMAI
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University)
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Minutes of

11th Board of studies Meeting

CURRICULUM (I – VIII) and (I-VII)

&

SYLLABUS (I – VIII) and (I-VII)

FOR

B.Tech – MECHANICAL ENGINEERING

(FULL TIME & PART TIME)

(Based on Outcome Based Education)

REGULATION – 2018 REVISION 1 (2019)

TABLE OF CONTENTS

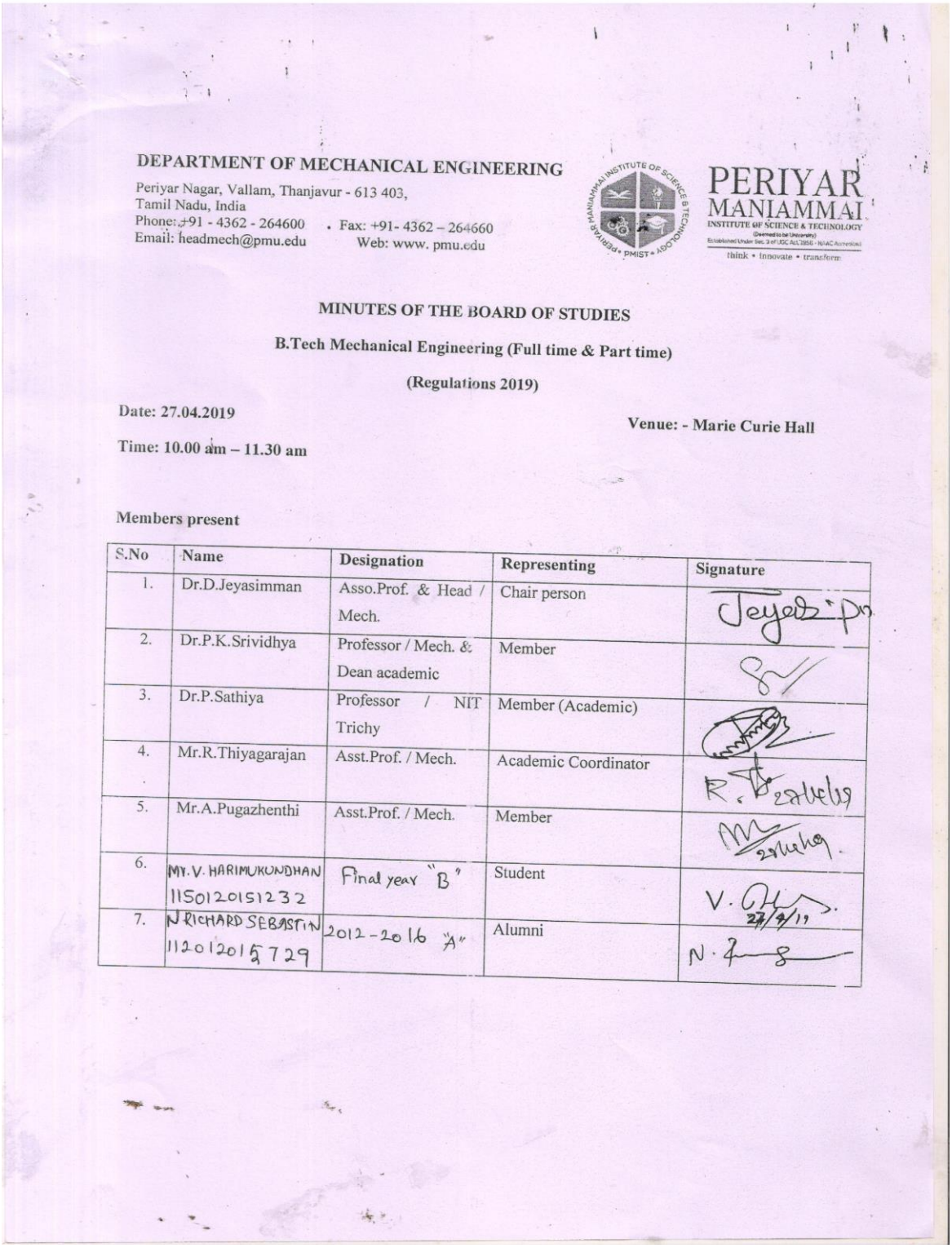
MEMBERS OF THE BOARD OF STUDIES

Sl.No.	Name	Designation	Membership
1.	Dr. D. Jeyasimman	Asso. Prof. & Head, Dept. of Mechanical Engg., PMIST	Chairperson
2.	Dr. P. Sathiya	Professor Dept. of Production Engg. NIT Trichy	External Member Representing academia
3.	Dr. P.K Srividhya	Professor/Mech. & Dean Academic, PMIST	Senior Member
4.	Mr.R.Thiyagarajan	Asst. Prof., Dept. of Mech. Engg., PMIST	Academic Coordinator
5.	Mr. A. Pugazhenthi	Asst. Prof., Dept. of Mech. Engg., PMIST	Member
6.	Mr.N.Richard Sebastin	Alumni 2012-16 batch, A sec 112012015729	Alumni Member
7.	Mr.A.Harimukundan	Final year Student, B sec 1150120151232	Student Member

The current Bachelor of Technology (B.Tech) Curriculum is undergoing its **Eleventh Board of studies on 27.04.2019** to tune the syllabus towards Outcome based Education and meet the UGC requirements and in turn the suggestions provided will be implemented in Regulations 2019-20.

It is thoroughly felt there is a need to change the present curriculum in order to produce engineers who possess skills that are employable. Hence, appropriate modification in the existing curriculum will augment the manpower and skill requirement of our country. The quality of an educational system can be judged from at least three perspectives: the inputs to the system, what happens within the system and the outputs from the system. In order to refine the input to the system, BoS members redefined the curriculum with the focus towards outcome based education.

In this connection, it is felt to frame the department vision and attain the vision through a well-structured mission framed in consultation with the faculty members and other administrators of PMU. The suggestion received during the Department Advisory Committee Meeting has also been brought to the notice of BOS members.



DEPARTMENT OF MECHANICAL ENGINEERING

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PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY
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MINUTES OF THE BOARD OF STUDIES

B.Tech Mechanical Engineering (Full time & Part time)

(Regulations 2019)

Date: 27.04.2019 **Venue: - Marie Curie Hall**

Time: 10.00 am – 11.30 am

Members present

S.No	Name	Designation	Representing	Signature
1.	Dr.D.Jeyasimman	Asso.Prof. & Head / Mech.	Chair person	
2.	Dr.P.K.Srividhya	Professor / Mech. & Dean academic	Member	
3.	Dr.P.Sathiya	Professor / NIT Trichy	Member (Academic)	
4.	Mr.R.Thiyagarajan	Asst.Prof. / Mech.	Academic Coordinator	
5.	Mr.A.Pugazhenthi	Asst.Prof. / Mech.	Member	
6.	MR.V. HARIMUKUNDHAN 115012015232	Final year "B"	Student	
7.	N RICHARD SEBASTIN 112012015729	2012-2016 "A"	Alumni	

DEPARTMENT OF MECHANICAL ENGINEERING

BOARD OF STUDIES MEETING

B.TECH MECHANICAL ENGINEERING (FULL & PART TIME)

Venue: - Marie Curie Hall

Date: - 27.04.2019
Time: - 10.00 am to 11. 30 am

Minutes of Meeting

1. In third semester consider some other professional core courses like Manufacturing processes and strength of materials instead of biology and Optics & Waves (Physics – II) course.
2. For improving employability skills of students can consider entrepreneurship development course as humanities and social sciences including management in third semester.
3. In fourth semester add Solid Mechanics course for the better understanding of students as they studying strength of materials in third semester if possible.
4. Add Professional ethics and human values course in fourth semester instead of Constitution of India.
5. In Fifth semester add Operation Research as Humanities I course.
6. Automobile engineering & CAD / CAM can be given as professional courses in fifth semester.
7. Consider Constitution of India course instead of Essence of Indian traditional knowledge in fifth semester.
8. Internship / Inplant training can be given as Project in fifth and sixth semester.
9. Project - III & IV course name can be given as Project phase – I & Project phase – II.
10. Finalize the List of Minor Courses Which you would like offer to the department?
11. Categorize the Professional elective courses based on streams like design, thermal, manufacturing…
12. Check and Verify the Total number of Credits, Course names, L-T-P-C & syllabus contents.

Agenda:

1. Framing Curriculum for B.Tech (Mechanical Engineering) full time and part time degree programme.
2. Developing Syllabus from (I – VIII) & (I – VII) semesters for B.Tech (Mechanical Engineering) full time and part time degree programme.
3. Checking the course outcomes mapping with program outcomes.

The members of Board of studies of Department of Mechanical Engineering met on 27.04.2019 and discussed and framed the curriculum and syllabus for B.Tech (Mechanical Engineering)(full time & part time) programme for Regulations 2019.

This will be submitted to the 32nd Academic council meeting to be conducted on 31.05.2019 for approval.

SUMMARY OF THE FEED BACK OBTAINED

Total number of feedback collected: 50

In that the following important observations were made,

1. Recent advancement should be added in course content.
2. New courses like Robotics and 3D Printing may be introduced.
3. More industrial visits to be accompanied during the course
4. More practical exposure, hands on training and site visits may be given
5. Models may be used to enhance the effectiveness of the teaching
6. To increase the importance of community involvement and social contribution by the students
7. To improve communication effectively, both orally and in writing
8. Exposure to events like seminars/conferences/Workshops outside
9. Improving social skills and language
10. Online courses may be provided.

I. **Revisions /Deletions/changes /Modifications including percentage of revision**

Sl. No.	Course Name	Modifications	Percentage of revision
	Professional Core subjects		
1.	Workshop practices	Addition - Processing of plastics and Smithy	25%
2.	Thermodynamics	Addition –Thermodynamic cycles and exergy Deletion-Psychrometry and Psychrometric chart	25%
3.	Fluid Mechanics & Machines	Addition –Application of Dimensionless number	10%
4.	Materials Engineering	Addition –NDT Deletion-Iron and Steel and Modern engineering materials	10%
5.	Instrumentation & Control	New course Introduced	100%
6.	Heat Transfer	Mass Transfer unit is removed	25%
7.	Mechanical Engineering Laboratory (Design) II	Addition- Bending deflection test on beams Strain measurement using Rosette strain gauge Microscopic examination of heat-treated and untreated metallic samples	25%
8.	Kinematics & Theory of Machines	Two courses are merged. No Change	0%
9.	Solid Mechanics	No Change	0 %
10.	Automation in Manufacturing	Addition-Modeling and Simulation	20%
11.	Mechanical Engineering Laboratory III (Manufacturing)	Addition- Drilling of a small hole using wire EDM Microprocessor controlled pick & place robot Use of Tool Maker's Microscope	30%
12.	Strength of Materials	Unit-II Shear flow (Removed) Unit III-Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column (Removed)	25%

		Unit V-Theories of Failure - Maximum shear stress - Strain energy in bending and torsion (Removed).	
13.	CAD CAM	Addition-Unit 3-shading, colouring, computer animation Unit 4-Assembly of parts- assembly modeling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking	25%
14.	Applied Thermodynamics	No change	0%
15.	Automobile Engineering	No change	0%
16.	Manufacturing Technology	No change	0%
17.	Design of Machine Elements	No change	0%

II List of new courses suggested

S. No.	Course Name	S. No.	Course Name
	Professional Core subjects		
1.	Instrumentation & Control	2.	Solid Mechanics
	Professional Elective subjects		
3	Energy Conservation and Management	4	Mathematical Modeling and Analysis
5	Microelectromechanical Systems	6	Composite Materials
7	Automotive Electronics		
	Minor courses		**Other Departments**
8	CNC Programming	11	Constitution of India
9	Pneumatics and Hydraulics	12	Human Ethics, Values, Rights And Gender Equality
10	Non Destructive Testing		

III Employability / Skill /entrepreneurship components in the syllabus of each course

	Course Name	Components
	Professional Core subjects	
1.	Manufacturing Technology	1.Operation of Jigs and fixtures, 2.Linear and angular measuring equipments, 3.Assembly of different components, 4. Basic concepts of PERT- CPM and their applications in product planning control. 5. Basic concepts of optimization, to formulate and Solve linear programming problems.
2.	CAD CAM	G code Based Milling and turning Programs writing
3.	Strength of Materials	-Tensile and compression testing of steel rods. -Mohr's circle drawing for multiple stress conditions
4.	Automation in Manufacturing	3D printing of CAD Models.
5.	Kinematics & Theory of Machines	New Working mechanisms in machines
6.	Solid Mechanics	Application to thick cylinders, rotating discs and torsion of non-circular cross-sections
	Professional Elective subjects	
7.	Gas Dynamics and Shock Waves	Flow Analysis Aircraft and Rocket propulsion
8.	Power Plant Engineering	Environmental issues of different power plants
9.	Refrigeration and Air conditioning	Skills required to model, analyse and design different refrigeration as well as air conditioning processes and components
10.	Renewable Energy Sources	Acquire knowledge of modern energy conversion technologies Identify appropriate energy conservation method to reduce the wastage of energy
11.	Advanced I.C Engines	Methods for improving the IC engine performance Latest developments in IC Engines and alternate fuels
12.	Energy Conservation and Management	Energy conservation in various mechanical applications
13.	Finite Element Analysis	Apply axisymmetric formulation for specific

		applications
14.	Design of Transmission Systems	Design the various clutches and Design braking system for various applications
15.	Mechanical Vibrations	Solve different vibration control problems
16.	Computational Fluid Dynamics	Solve fluid flow field calculations using CFD models
17.	Machine Drawing	Apply tolerances and fits in the drawings Understand the codes and practices
18.	Design of Jigs and Fixtures and press tools	Understand the locating and clamping principles Understand various forming techniques.
19.	Mathematical Modeling and Analysis	Develop simulation code for real-time problem Solve the problem using simulation tools
20.	Computer Aided Design	Apply fundamentals of computer graphics and relate 2D and 3D transformations. Interpret relevant CAD Standards
21.	Unconventional Manufacturing Technology	Understand principles of material removal mechanism of advanced machining processes such as mechanical, electro-chemical processes
22.	Microelectromechanical Systems	Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process
23.	Industrial Safety	Evaluate the safety performance of an organization from accident records Study important legislations related to Health , Safety and Environment
24.	Industrial Robotics	Understand about robot configurations and drives Analyze the robot programming
25.	Total Quality Management	Analyze and Explain the Customer satisfaction, Employee involvement, supplier selection and appraise the performance by TQM principle
26.	Product Design and Development	Find the various product specifications and principles needed for the product development process. Understand the various techniques involved in the prototyping process
27.	Computer Integrated Manufacturing	Compare the system modeling tools in CIM and the fundamental concepts of data communications. Discuss the applications of database and system

		protocol
28.	Process Planning and Cost Estimation	Understand about material selection and Process planning and its factors , parameters Analyze various costs, allowances and machining time for various operations
29.	Composite Materials	Analyze various manufacturing methods of composite materials Understand the mechanical behaviour of Composite materials
30.	Automotive Electronics	Analyze the concepts of automotive electronic engine management system, dashboard and warning systems
	Minor courses	
31.	CNC Programming	CNC part programming and Hardware Analysis
32.	Pneumatics and Hydraulics	Sensors and actuators working anlysis
33.	Non Destructive Testing	Practical knowledge of Testing Techniques
	Other Departments	
46.	Human Ethics, Values, Rights And Gender Equality	-
47.	Cyber Security	Software and Hardware Security
48.	Constitution of India	New course

IV. VALUE ADDED COURSES SUGGESTED

1. AUTOCAD –Drafting
2. CREO-Software
3. CATIA-Software
4. MEP Engineering design –Mechanical Electrical and Plumbing design software
5. Non Destructive Testing
6. ANSYS Software

V. Activities with direct bearing on enhancing employability/skill development/ entrepreneurship

	Course Name	List of Activities
	Professional Core subjects	
1.	Manufacturing Technology	1.Jig design 2.Linear and angular measuring equipments principle of operation and applications 3. Solve linear programming problems .
2.	CAD CAM	2 day training on CAM simulation at CAD/CAM lab.
3.	Strength of Materials	1 day training course on 3D stress analysis in CAD systems. Activity: Creating stress distribution in mechanical components.
4.	Automation in Manufacturing	2 Day Industrial Visit on 3D printing
5.	Kinematics & Theory of Machines	Training on structural analysis
6.	Solid Mechanics	3 day training course on design and analysis software (ANSYS) Activity: Stress and deformation study on basic mechanical elements using ANSYS.
	Professional Elective subjects	
7.	Gas Dynamics and Shock Waves	Shock waves demonstration
8.	Power Plant Engineering	Mettur Dam visit
9.	Refrigeration and Air conditioning	Air Conditioning service training
10.	Renewable Energy Sources	Solar power generation and wind power generation demonstration
11.	Advanced I.C Engines	Smoke Test and engine performance test demonstration
12.	Energy Conservation and Management	Energy Audit Training
13.	Finite Element Analysis	Load and Structure analyses
14.	Design of Transmission Systems	Various Shaft and Gear drives mini project
15.	Mechanical Vibrations	Damping Characteristics Study

16.	Computational Fluid Dynamics	Flow analysis
17.	Machine Drawing	Assembly Drawing and part drawing analysis
18.	Design of Jigs and Fixtures and press tools	Design practices of various Jigs and Fixtures
19.	Mathematical Modeling and Analysis	Application of Modeling techniques
20.	Computer Aided Design	Geometric modeling analysis
21.	Unconventional Manufacturing Technology	NIT trichy visit-wire cut EDM and Laser Machining
22.	Microelectromechanical Systems	NIT trichy visit-Robotics
23.	Industrial Safety	Industry visit and safety measures
24.	Industrial Robotics	NIT trichy visit-Robotics
25.	Total Quality Management	Application of 5S principles
26.	Product Design and Development	Proto type model Development
27.	Computer Integrated Manufacturing	CNC and VMC Machine Hardware Interface Study
28.	Process Planning and Cost Estimation	Economical analysis
29.	Composite Materials	SEM analysis of Composite Materials
30.	Automotive Electronics	Study of sensors and actuators
	Other Departments	
33.	Human Ethics, Values, Rights And Gender Equality	Collection of details on conflict and arbitrations
34.	Constitution of India	Collection and compilation of various constitution law

VII. OVERALL PERCENTAGE OF CHANGE COMPARED TO REGULATIONS 2018

10%

Jeyad 27/04/2019

Dr. D. JEYASIMMAN, M.E., Ph.D,
Associate Professor & Head,
Department of Mechanical Engg,
Periyar Maniammai Institute of
Science & Technology,
THANJAVUR - 613 403.

PERIYAR MANIAMMAI INSTITUTE OF SCIENCE AND TECHNOLOGY

Our Institution is committed to the following Vision, Mission and core values, which guide us in carrying out our Mechanical Engineering Department mission and realizing our vision:

INSTITUTION VISION	
To be a Institution of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society.	
INSTITUTION MISSION	
IM1	Offering well balanced programmes with scholarly faculty and state-of-art facilities to impart high level of knowledge.
IM2	Providing student - centered education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and collaborative work.
IM3	Involving progressive and meaningful research with concern for sustainable development.
IM4	Enabling the students to acquire the skills for global competencies.
IM5	Inculcating Universal values, Self respect, Gender equality, Dignity and Ethics.

INSTITUTION CORE VALUES

- Student – centric vocation
- Academic excellence
- Social Justice, equity, equality, diversity, empowerment, sustainability
- Skills and use of technology for global competency.
- Continual improvement
- Leadership qualities.
- Societal needs
- Learning, a life – long process
- Team work
- Entrepreneurship for men and women

- Rural development
- Basic, Societal, and applied research on Energy, Environment, and Empowerment.

DEPARTMENT OF MECHANICAL ENGINEERING

DEPARTMENT VISION	
To be recognized globally for outstanding education and research in all fields of mechanical engineering leading to well qualified engineers, who are innovative, entrepreneurial and successful in studies.	
DEPARTMENT MISSION	
DM1	To inculcate basic mechanical engineering knowledge to students through effective teaching– learning practices with state of art facilities.
DM2	To impart quality education to enable the students for higher studies, research and entrepreneurship.
DM3	To carry out research activities to satisfy the societal and industrial needs towards sustainability.
DM4	To provide our students with educational experiences that gives them a sound basis for global requirements, team work and lifelong learning.
DM5	To cater the needs of society in context of mechanical engineering with human ethics values.

Department Vision and Mission Definition Process

The development of vision and mission of the department is carried out as per the following steps.

Step: I Brainstorming carried out at different levels
First level - Department faculty by the HOD
Second level – Current students by the faculty
Third level - Employers, alumni and academia and industry experts

Step: II Benchmarking with other Institutions: Understanding the Vision and Mission

Step: III Validation by the Board of studies and then Academic Council

Step: IV Wide publicity in the department and Institution

The Institution Vision is split up into small elements and verifies its compliance with Department Vision

INSTITUTION VISION	DEPARTMENT VISION
global dynamism	To be recognized globally for outstanding education
excellence in knowledge and innovation	Engineers, who are innovative, entrepreneurial and successful in studies.
ensuring social responsibility	Contribute to the socio-economic development of the nation through research and consultancy.
Creating an egalitarian society.	

To accomplish the vision stated, well-structured mission is established with consultation with administrators, faculty members and other officials.

INSTITUTION MISSION	DEPARTEMNT MISSION
Well balanced programmes with scholarly faculty	Effective teaching– learning practices with state of art facilities.
To impart high level of knowledge	To inculcate basic mechanical engineering knowledge to students
Student - centered education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and	Quality education to enable the students for higher studies, research and entrepreneurship

collaborative work.	
Progressive and meaningful research with concern for sustainable development.	To carry out research activities to satisfy the societal and industrial needs
Inculcating Universal values, Self respect, Gender equality, Dignity and Ethics.	To cater the needs of society in context of mechanical engineering with human ethics values.

Table: 1 Mapping of Institution Mission (IM) and Department Mission (DM)

	IM 1	IM 2	IM 3	IM 4	IM 5
DM 1	3	1	1	1	1
DM 2	2	3	2	1	0
DM 3	1	1	3	1	2
DM 4	1	2	1	3	1
DM5	1	1	1	1	3
	8	**8**	**8**	**7**	**7**

1-Low 2- Medium 3 – High

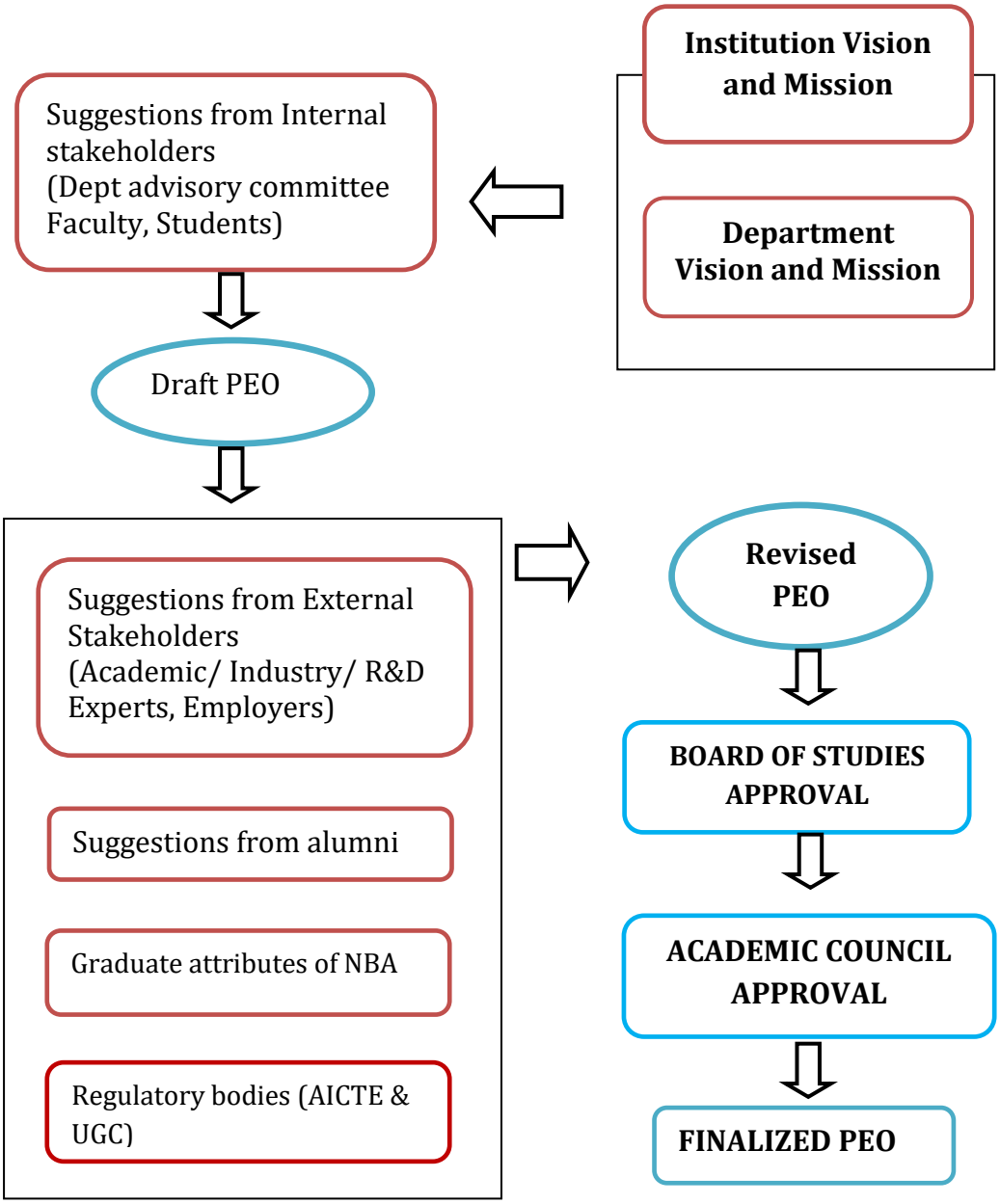
PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

Based on the mission of the department, the programme educational objectives is formulated as

PEO1	Mechanical Engineering graduate shall have successful career with good leadership & team work abilities.
PEO2	Graduate pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.
PEO3	Graduate shall have ability to apply core technical competency to various engineering problems along with sense of social awareness.
PEO4	Graduate shall engage in lifelong learning by applying contextual technological knowledge for research and value education.

PEO PROCESS ESTABLISHMENT

The faculty of the Mechanical Engineering department at our institution met on different occasions for discussion and a final work session to complete the steps of the process in order to draft the set of PEOs for Mechanical Engineering Department to assess the graduates few years after graduation.



The framework for the review and revision of the PEOs at the departmental level involving all the faculty members comprised the following broad stages.

1. Using the key words and phrases extracted from the Mission Statement of the institution and department to identify attributes to gauge graduates.
2. Capturing the distinction between the educational objective and the student outcomes.

3. Formulating each objective to be measurable.

The program educational objectives for the Mechanical engineering program describe accomplishments that graduates are expected to attain within five years after graduation. Graduates will have applied their expertise to contemporary problem solving, be engaged professionally, and have continued to learn and adapt, and have contributed to their organizations through leadership and teamwork.

Mapping of Program Educational Objectives (PEOs) with Department Mission (DM)

	DM 1	**DM 2**	**DM3**	**DM 4**
PEO 1	3	2	1	1
PEO 2	2	3	2	1
PEO 3	1	1	3	2
PEO 4	2	1	1	3
	8	**7**	**7**	**7**

1- Low 2 – Medium 3-High

The development of vision, mission and programme educational objectives is tuned in line with the global and national standards and it is assured that the department vision and mission will facilitate in meeting the vision and mission of the Institution.

The Program Educational Objectives shall cover both technical and professional aspects of the expected achieve-Achievement in terms of technical skills required in the profession for which the program prepares students

- Achievements in terms of professional, ethical, and Communicational aspects required by the profession for which the program prepares students (team work, ethical behavior, effective communication, etc.)
- Achievements in terms of management and leadership skills (project managers, directors, CTOs, CEOs, etc.)
- Achievements in terms of life-long learning and continuous education (certifications, conferences and workshops attendance, etc.)
- Achievements in terms of advanced and graduate studies pursuing (graduate studies, research careers, etc.)

- Other aspects could be considered when defining educational objectives such as the ability to engage in entrepreneurship activities

PROGRAMME OUTCOME (PO)

At the time of graduation, competency of the student is measured through the attainment of programme outcomes. The quantification of programme outcomes attainment is measured through the assessment of established course outcomes for each subject.

PROGRAM OUTCOMES	
PO 1	An ability to apply principles of engineering, basic science, and mathematics to model and analyze components or processes
PO 2	An ability to design and conduct experiments, as well as to analyze and interpret data
PO 3	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability
PO 4	An ability to function on multi-disciplinary teams
PO 5	An ability to identify, formulate, and solve engineering problems
PO 6	An understanding of professional and ethical responsibility
PO 7	An ability to communicate effectively
PO 8	Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
PO 9	An ability to engage in life-long learning
PO 10	A knowledge of contemporary issues
PO 11	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
PO 12	An ability to imbibe principles of engineering, basic science, and mathematics to design and realize physical systems, components, or processes
PROGRAM SPECIFIC OUTCOME	
PSO1	an ability to work professionally in ***design and manufacturing*** systems

PSO2	an ability to work professionally in ***energy*** systems

GRADUATE ATTRIBUTES

1. **Knowledge base for Engineering:** Demonstrate competence in mathematics, natural sciences, engineering fundamentals and specialized engineering knowledge appropriate to the programme.
2. **Analytical Skills:** Identify, formulate, analyse and solve diverse engineering problems.
3. **Design:** Solution for complicated open–ended engineering problems and design the components with appropriate standards to meet specified needs with proper attention to public health, safety, environment and society.
4. **Experimental Investigation:** Technical skills to conduct investigation, interpretation of observed data and provide solution for multifaceted problems.
5. **Modern Engineering tools usage**: Acquire, select, manipulate relevant techniques, resources and advanced engineering ICT tools to operate simple to complex engineering activities.
6. **Impact of engineering on society:** Provide a product / project for use by the public towards their health, welfare, safety and legal issues to serve the society effectively.
7. **Environment and Sustainability:** Design eco-friendly and sustainable products in demonstrating the technology development to meet present and future needs.
8. **High Ethical Standards:** Practice ethical codes and standards endorsed by professional engineers.
9. **Leadership and team work:** Perform as an individual and as a leader in diverse teams and in multi-disciplinary scenarios.
10. **Communication Skills:** Professional communication with the society to comprehend and formulate reports, documentation, effective delivery of presentation and responsible to clear instructions.
11. P**roject management and Finance:** Appropriate in incorporating finance and business practices including project, risk and change management in the practice of engineering by understanding their limitations.

12. **Life-long learners:** Update the technical needs in a challenging world in equipping themselves to maintain their competence.

Table: 3 Mapping of Program Educational Objectives (PEOs) with Program Outcomes (POs)

PO→	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO 2
PEO 1	1	0	2	3	1	1	3	1	2	1	1	1	1	1
PEO 2	3	2	1	1	2	1	1	1	1	1	2	1	2	1
PEO 3	2	2	3	0	2	3	0	2	0	2	1	1	1	1
PEO 4	0	2	1	1	1	1	2	1	3	1	2	2	1	1
Total	**6**	**6**	**7**	**5**	**6**	**6**	**6**	**5**	**6**	**5**	**6**	**5**	**5**	**4**

1 - Low 2 – Medium 3 – High

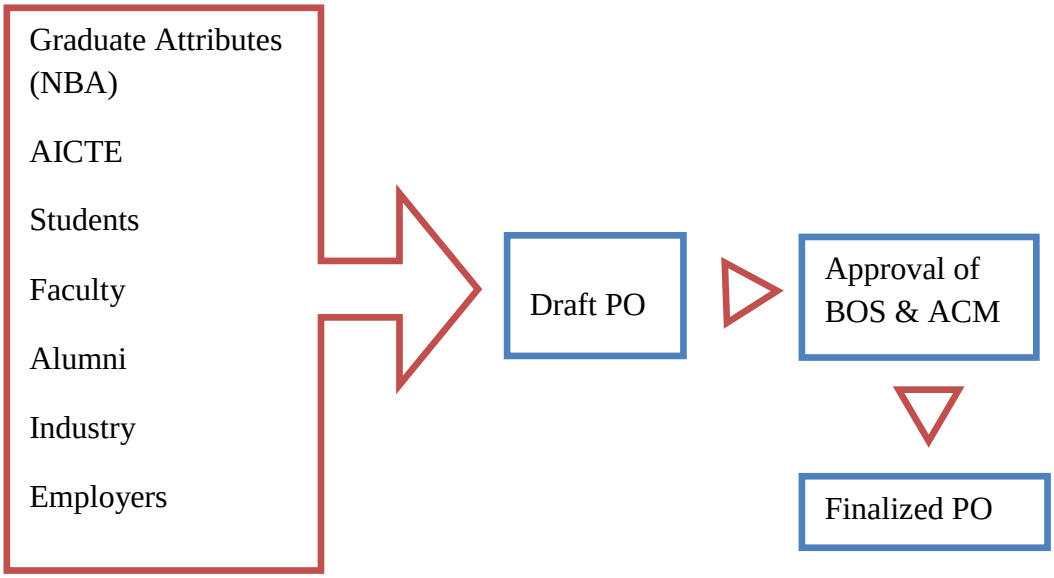
Table: 4 Mapping of Program Outcomes (POs) with Graduate Attributes (GAs)

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA 12
PO1	3	2	2	1	1	2	1	1	1	2	2	1
PO2	2	2	3	2	1	2	1	1	2	1	1	2
PO3	2	2	2	3	3	1	2	1	1	2	1	2
PO4	2	2	3	3	1	2	1	1	2	2	1	2
PO5	2	1	3	2	3	3	3	2	2	3	1	2
PO6	3	2	2	1	1	2	1	1	1	2	2	1
PO7	2	2	1	1	2	3	2	3	2	1	2	2
PO8	2	1	1	2	1	3	2	2	2	3	1	2
PO 9	2	1	1	2	3	3	2	2	3	3	1	3
PO10	2	2	1	1	2	3	2	3	2	1	2	2
PO11	2	1	2	3	2	3	1	3	3	2	1	3
PO12	2	2	2	3	3	1	2	1	1	2	1	2

PSO1	2	1	2	2	1	3	2	2	2	3	1	2
PSO2	2	2	2	2	3	1	2	1	1	2	1	2

1- Slightly **2 – Supportive** **3 - Highly related**

PO PROCESS ESTABILSHMENT



CURRICULUM DEVELOPMENT

The faculty members have been allotted for developing the courses and its outcomes as given below. They in turn conducted frequent discussions with each other and with students in drafting the course content.

The curriculum development is ensured that students receive integrated, coherent learning experiences that contribute towards their personal, academic and professional learning and development.

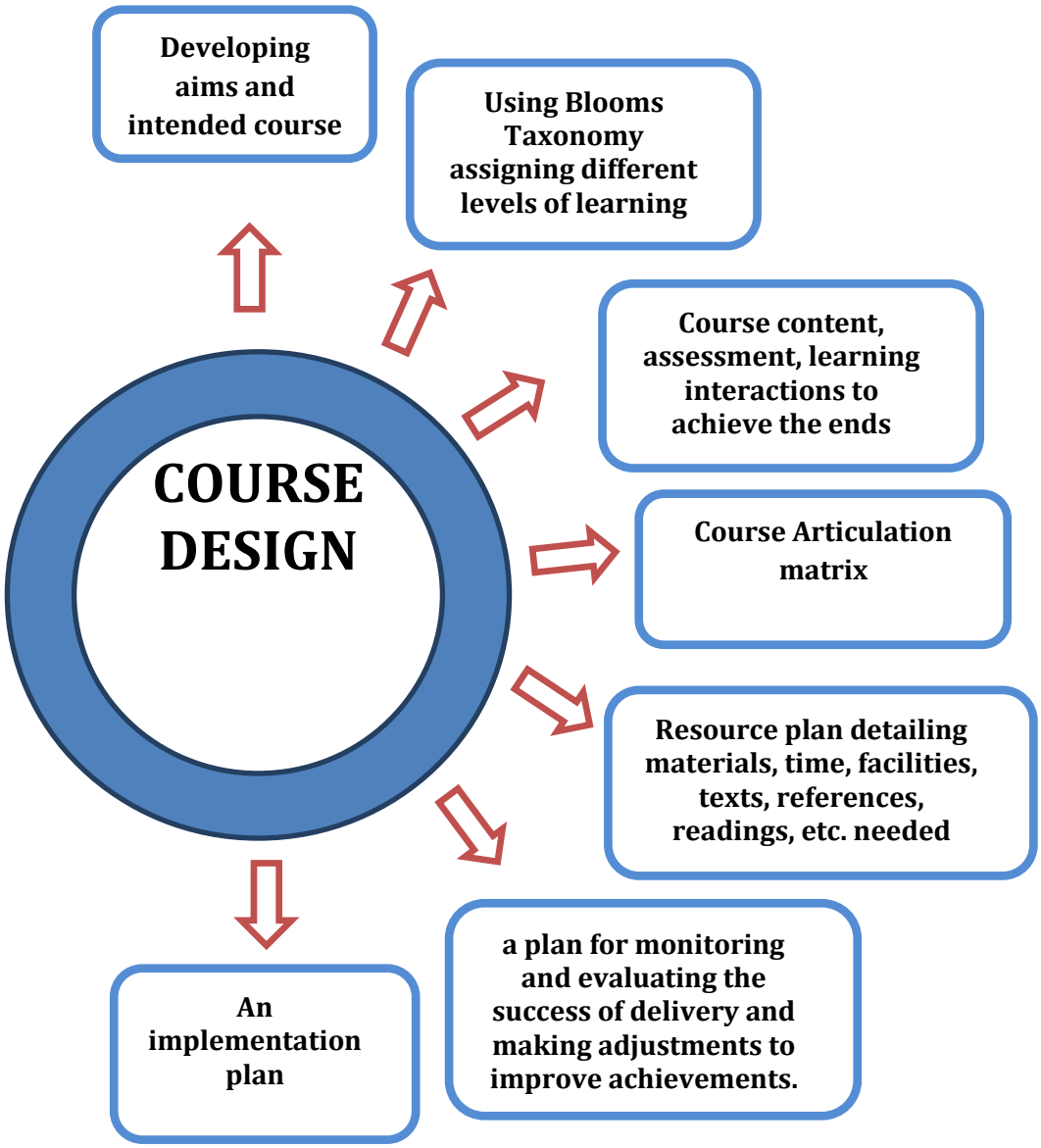
Courses and topics were designed and developed within a framework which comprises a specified curriculum, specified assessment arrangements, and clearly identified educational aims and learning outcomes.

Faculty members assigned for course development

S. No	Course Name	Staff In charge
1.	Heat transfer	Mr.J.Kesavan
2.	Solid Mechanics	Mr.A.Pugazhenthi
3.	Manufacturing Processes	Mr.S.P.Manikandan
4.	Kinematics & Theory of Machines	Mr.V.Pandiyaraj
5.	Mechanical Engineering Lab-1 (Thermal)	Mr.T.Aneesh
6.	Manufacturing Technology	Mr.R.Udhayasankar
7.	Design of Machine Elements	Mr.A.Mohamed Ismail
8.	Mechanical Engineering Lab-1I (Design)	Mr.T.Aneesh
9.	Automation in Manufacturing	Mr.N.Shivakumar
10.	Mechanical Engineering Lab-1II (Manufacturing)	Mr.T.Aneesh
11.	Strength of Materials	Mr.N.Shivakumar
12.	Fluid Mechanics and Machines	Mr.J.Thiyagarajan
13.	Engineering Mechanics	Mr.V.Pandiyaraj
14.	Thermodynamics	Mr.J.Thiyagarajan
15.	Engineering Graphics	Mr.C.M.Vivek
16.	Workshop Practices	Mr.N.Shivaharinathan
17.	Materials Engineering	Mr.J.Kesavan
18.	Instrumentation & Control	Mr.R.Thiyagarajan
	Professional Elective subjects	
19.	I.C.Engines	Mr.J.Kesavan
20.	Mechatronics	M.P.Srinivasan
21.	Refrigeration & Air Conditioning	Mr.V.Pandiyaraj
22.	Total Quality Management	Mr.R.Thiyagarajan
23.	CAD/CAM	Mr.C.M.Vivek
24.	Power Plant Engineering	Mr.J.Thiyagarajan
	Minor courses	
25.	CNC Programming	Mr.J.Kesavan
26.	Pneumatics & Hydraulics	Mr.P.Srinivasan
27.	Non Destructive Testing	Mr.C.M.Vivek
	Other Departments	
28.	Operation Research	Dr.P.Vijayalakshmi
29.	Ethics & Human Values	Dr.K.V.Rajendran
30.	Constitution of India	Dr.K.Selavakumar/Political Science

COURSE DEVELOPMENT

The following elements were developed by the faculty involved after interaction and discussions.



In aligning programme outcome and graduate attributes, course offered to the degree programme are finalized based on the standard template finalized by the Institution.

Distribution of Subjects to be included as per UGC and NAAC

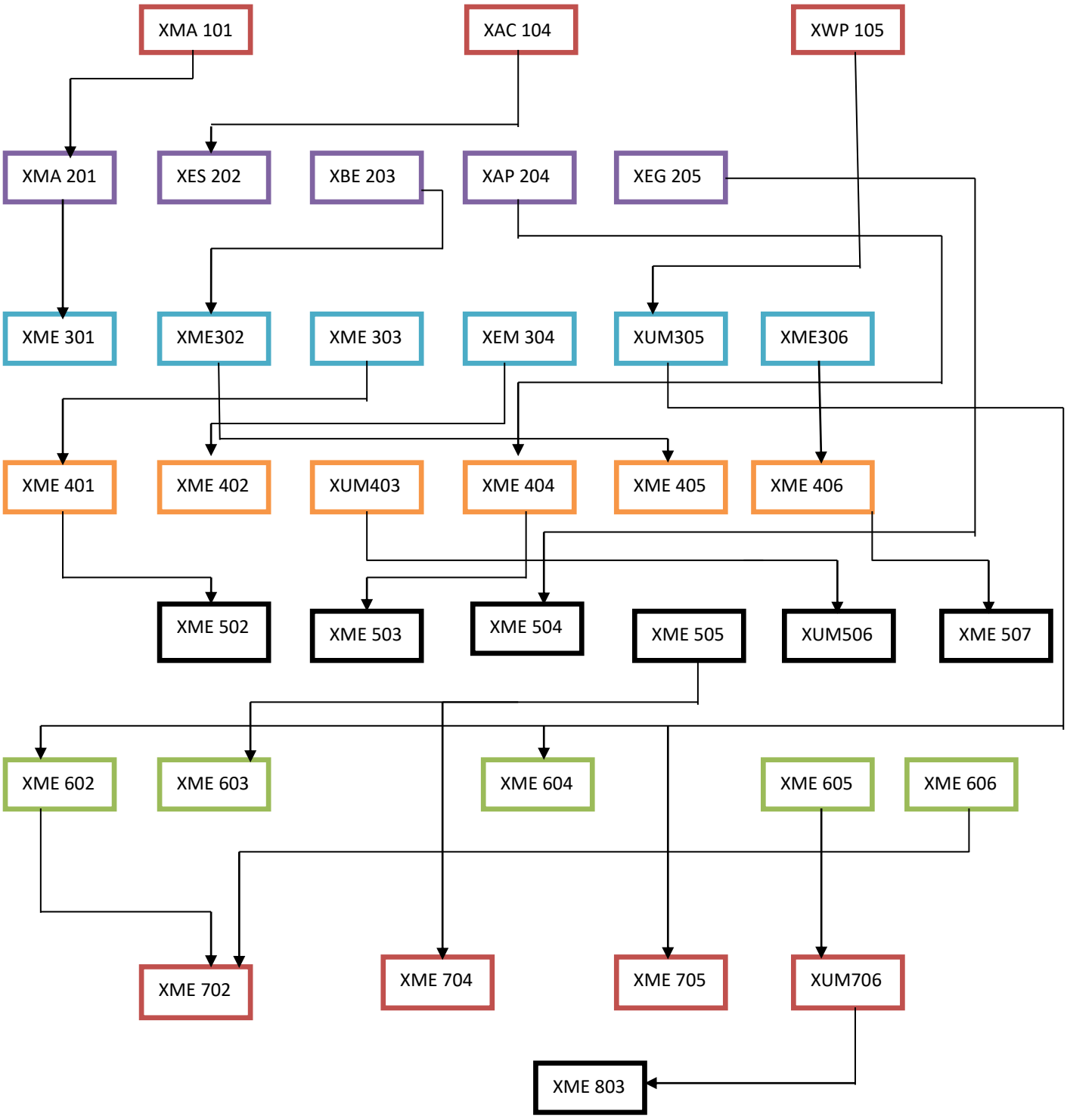
S.No	Category	Symbol
1.	Humanities and Social Sciences (HS), including Management;	HS
2.	Basic Sciences(BS) including Mathematics, Physics, Chemistry, Biology;	BS
3.	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation;	ES
4.	Professional Subjects-Core (PC), relevant to the chosen specialization/branch;	PC
5.	Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch;	PE
6.	Open Subjects- Electives (OE), from other technical and/or emerging subject areas;	OE
7.	Project Work, Seminar and/or Internship in Industry or elsewhere	PW/PI
8.	Mandatory Courses (UGC Mandatory)	MC
9.	Non-credit Course	ELS
10.	NCC/NSS/YRC/RRC/Sports	

SUMMARY OF CREDITS

Category	I	II	III	IV	V	VI	VII	VIII	Total	As suggested By AICTE * Model curriculum
HS	3		3			3			9	12
BS	9	10	4						23	25
ES	8	8	4	3					23	24
PC			11	16	16	10	5		58	48
PE						6	9	3	18	18
OE					4		3	6	13	18
PW/PI							6	6	12	15
MC		0		0	0	0	0		0	0
Total	20	18	22	19	20	19	23	15	156	160

*** flexibility of +/- 20%**

PRE REQUISITE MAPPING



SEMESTER-WISE STRUCTURE OF CURRICULUM

REGULATIONS – 2018 Revision 1 (2019)

(Applicable to the students admitted from the Academic year 2019-20 onwards)

SEMESTER I

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
XMA101	Basic Science course	Calculus and Linear Algebra	3	1	0	4
XCP102	Engineering Science course	Programming for Problem Solving	3	0	4	5
XGS103	Humanities courses	English	2	0	2	3
XAC104	Basic Science course	Applied Chemistry for Engineers	3	1	2	5
XWP105	Engineering Science course	Workshop Practices	2	0	2	3
	TOTAL					**20**

SEMESTER II

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
XMA201	Basic Science course	Calculus, Ordinary Differential Equations and Complex Variable	3	1	0	4
XES202	Mandatory Courses	Environmental Sciences	3	0	0	0
XBE203	Engineering Science course	Electrical and Electronic Engineering Systems	3	2	2	5
XAP204	Basic Science course	Applied Physics for Engineers	3	1	4	6
XEG205	Engineering Science course	Engineering Graphics	2	0	2	3
	TOTAL					**18**

SEMESTER III

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
XME301	Basic Science Courses	PDE, Probability & Statistics	3	1	0	4
XME302	Professional Core courses	Thermodynamics	3	1	0	4
XME303	Professional Core Courses	Strength of Materials	3	1	0	4
XEM304	Engineering Science courses	Engineering Mechanics	3	1	0	4
XUM305	HSMC	Entrepreneurship Development	3	0	0	3
XME306	Professional Core courses	Manufacturing Processes	3	0	0	3
XME307	Project (Summer internship)	Inplant Training – I (15 days)	0	0	2	0
	TOTAL					**22**

SEMESTER IV

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
XME401	Professional Core Courses	Applied Thermodynamics	3	1	0	4
XME402	Professional Core courses	Solid Mechanics	3	1	0	4
XUM403	Mandatory Courses	Human Ethics, Values, Rights and Gender Equality	3	0	0	0
XME404	Professional Core Courses	Fluid Mechanics & Fluid Machines	3	1	0	4
XME405	Engineering Science Courses	Materials Engineering	3	0	0	3
XME406	Professional Core courses	Instrumentation & Control	3	1	0	4
	TOTAL					**19**

SEMESTER V

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
XME501	Humanities courses	Operation Research	3	1	0	4
XME502	Professional Core courses	Heat Transfer	3	1	0	4
XME503	Professional Core courses	Automobile Engineering	3	0	0	3
XME504	Professional Core courses	CAD/CAM	3	0	0	3
XME505	Professional Core courses	Kinematics & Theory of Machines	3	1	0	4
XUM506	Mandatory course	Constitution of India	2	0	0	0
XME507	Professional Core courses	Mechanical Engineering Laboratory I (Thermal)	0	0	4	2
XME508	Project (Summer internship)	Inplant Training – II (21 days)	0	0	2	0
XMEM01	Minor Course	CNC Programming for Lathe Operations	0	0	2	0
	TOTAL					**20**

SEMESTER VI

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
XUM601	Humanities and Social Sciences	Economics for Engineers	3	0	0	3
XME602	Professional Core courses	Manufacturing Technology	4	0	0	4
XME603	Professional Core courses	Design of Machine Elements	3	1	0	4
	Professional Elective courses	Elective-I	3	0	0	3
	Professional Elective courses	Elective-II	3	0	0	3
XME606	Professional Core courses	Mechanical Engineering Laboratory II (Design)	0	0	4	2
XMEM02	Minor Course	Pneumatics and Hydraulics	0	0	2	0
	TOTAL					**19**

SEMESTER VII

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
	Open Elective Courses	Open Elective-I	3	0	0	3
XME702	Professional Core courses	Automation in Manufacturing	3	0	0	3
	Professional Elective Courses	Elective III	3	0	0	3
	Professional Elective Courses	Elective-IV	3	0	0	3
	Professional Elective Courses	Elective V	3	0	0	3
XUM706	UGC- MC	Cyber Security	3	0	0	0
XME707	Professional Core courses	Mechanical Engineering Laboratory III (Manufacturing)	0	0	4	2
XME708	Project	Project phase – I	0	0	8	4
XME709	Project (Summer internship)	Inplant Training – III (30 days)	0	0	4	2
XMEM03	Minor Course	Non Destructive Testing	0	0	2	0
	TOTAL					**23**

SEMESTER VIII

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
	Open Elective Courses	Open Elective-II	3	0	0	3
	Open Elective Courses	Open Elective-III	3	0	0	3
	Professional Elective Courses	Elective VI	3	0	0	3
XME804	Project	Project phase – II	0	0	12	6
	TOTAL					**15**

TOTAL CREDITS – 156

OPEN ELECTIVE COURSES

(OPEN ELECTIVES OFFERED BY MECHANICAL ENGINEERING DEPARTMENT)

CODE. No	Course Title	Credits			
		L	T	P	C
XMEOE1	Product Design and Development	3	0	0	3
XMEOE2	Renewable Energy Sources	3	0	0	3
XMEOE3	Microelectromechanical Systems	3	0	0	3

PROFESSIONAL ELECTIVE COURSES LIST

Course Code No	Course Title	Credits			
		L	T	P	C
TRACK – I (Thermal Stream)					
XMEE01	Gas Dynamics and Shock Waves	3	0	0	3
XMEE02	Power Plant Engineering	3	0	0	3
XMEE03	Refrigeration and Air conditioning	3	0	0	3
XMEE04	Renewable Energy Sources	3	0	0	3
XMEE05	Advanced I.C Engines	3	0	0	3
XMEE06	Energy Conservation and Management	3	0	0	3
Code No	**Course Title**	**Credits**			
		L	**T**	**P**	**C**
TRACK – II (Design Stream)					
XMEE07	Finite Element Analysis	3	0	0	3
XMEE08	Design of Transmission Systems	3	0	0	3
XMEE09	Mechanical Vibrations	3	0	0	3
XMEE10	Computational Fluid Dynamics	3	0	0	3
XMEE11	Machine Drawing	3	0	0	3
XMEE12	Design of Jigs and Fixtures and press tools	3	0	0	3
XMEE13	Mathematical Modeling and Analysis	3	0	0	3
XMEE14	Computer Aided Design	3	0	0	3

Code No	Course Title	Credits			
		L	T	P	C
TRACK – III (Manufacturing Stream)					
XMEE15	Unconventional Manufacturing Technology	3	0	0	3
XMEE16	Microelectromechanical Systems	3	0	0	3
XMEE17	Industrial Safety	3	0	0	3
XMEE18	Industrial Robotics	3	0	0	3
XMEE19	Total Quality Management	3	0	0	3
XMEE20	Product Design and Development	3	0	0	3
XMEE21	Computer Integrated Manufacturing	3	0	0	3
XMEE22	Process Planning and Cost Estimation	3	0	0	3
XMEE23	Composite Materials	3	0	0	3
XMEE24	Automotive Electronics	3	0	0	3
XMEE25	Reliability Engineering	3	0	0	3

MINOR COURSES

Code No	Course Title	Credits			
		L	T	P	C
XMEM01	CNC Programming for Lathe Operations	0	0	2	0
XMEM02	Pneumatics and Hydraulics	0	0	2	0
XMEM03	Non Destructive Testing	0	0	2	0

I. Revisions /Deletions/changes /Modifications including percentage of revision

Sl. No.	Course Name	Modifications	Percentage of revision
	Professional Core subjects		
1.	Workshop practices	Addition - Processing of plastics and Smithy	25%
2.	Thermodynamics	Addition –Thermodynamic cycles and exergy Deletion-Psychrometry and Psychrometric chart	25%
3.	Fluid Mechanics & Machines	Addition –Application of Dimensionless number	10%
4.	Materials Engineering	Addition –NDT Deletion-Iron and Steel and Modern engineering materials	10%
5.	Instrumentation & Control	New course Introduced	100%
6.	Heat Transfer	Mass Transfer unit is removed	25%
7.	Mechanical Engineering Laboratory (Design) II	Addition- Bending deflection test on beams Strain measurement using Rosette strain gauge Microscopic examination of heat-treated and untreated metallic samples	25%
8.	Kinematics & Theory of Machines	Two courses are merged. No Change	0%
9.	Solid Mechanics	No Change	0 %
10.	Automation in Manufacturing	Addition-Modeling and Simulation	20%
11.	Mechanical Engineering Laboratory III (Manufacturing)	Addition- Drilling of a small hole using wire EDM Microprocessor controlled pick & place robot Use of Tool Maker's Microscope	30%
12.	Strength of Materials	Unit-II Shear flow (Removed) Unit III-Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column (Removed) Unit V-Theories of Failure - Maximum shear stress - Strain energy in bending and torsion (Removed).	25%
13.	CAD CAM	Addition-Unit 3-shading, colouring, computer animation	25%

		Unit 4-Assembly of parts- assembly modeling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking	
14.	Applied Thermodynamics	No change	0%
15.	Automobile Engineering	No change	0%
16.	Manufacturing Technology	No change	0%
17.	Design of Machine Elements	No change	0%

II List of new courses suggested

S. No.	Course Name	S. No.	Course Name
	Professional Core subjects		
1.	Instrumentation & Control	2.	Solid Mechanics
	Professional Elective subjects		
3	Energy Conservation and Management	4	Mathematical Modeling and Analysis
5	Microelectromechanical Systems	6	Composite Materials
7	Automotive Electronics		
	Minor courses		**Other Departments**
8	CNC Programming	11	Constitution of India
9	Pneumatics and Hydraulics	12	Human Ethics, Values, Rights And Gender Equality
10	Non Destructive Testing		

III Employability / Skill /entrepreneurship components in the syllabus of each course

	Course Name	Components
	Professional Core subjects	
1.	Manufacturing Technology	1.Operation of Jigs and fixtures, 2.Linear and angular measuring equipments, 3.Assembly of different components, 4. Basic concepts of PERT- CPM and their applications in product planning control. 5. Basic concepts of optimization, to formulate and Solve linear programming problems.
2.	CAD CAM	G code Based Milling and turning Programs writing
3.	Strength of Materials	-Tensile and compression testing of steel rods.

		-Mohr's circle drawing for multiple stress conditions
4.	Automation in Manufacturing	3D printing of CAD Models.
5.	Kinematics & Theory of Machines	New Working mechanisms in machines
6.	Solid Mechanics	Application to thick cylinders, rotating discs and torsion of non-circular cross-sections
	Professional Elective subjects	
7.	Gas Dynamics and Shock Waves	Flow Analysis Aircraft and Rocket propulsion
8.	Power Plant Engineering	Environmental issues of different power plants
9.	Refrigeration and Air conditioning	Skills required to model, analyse and design different refrigeration as well as air conditioning processes and components
10.	Renewable Energy Sources	Acquire knowledge of modern energy conversion technologies Identify appropriate energy conservation method to reduce the wastage of energy
11.	Advanced I.C Engines	Methods for improving the IC engine performance Latest developments in IC Engines and alternate fuels
12.	Energy Conservation and Management	Energy conservation in various mechanical applications
13.	Finite Element Analysis	Apply axisymmetric formulation for specific applications
14.	Design of Transmission Systems	Design the various clutches and Design braking system for various applications
15.	Mechanical Vibrations	Solve different vibration control problems
16.	Computational Fluid Dynamics	Solve fluid flow field calculations using CFD models
17.	Machine Drawing	Apply tolerances and fits in the drawings Understand the codes and practices
18.	Design of Jigs and Fixtures and press tools	Understand the locating and clamping principles Understand various forming techniques.
19.	Mathematical Modeling and Analysis	Develop simulation code for real-time problem Solve the problem using simulation tools
20.	Computer Aided Design	Apply fundamentals of computer graphics and relate 2D and 3D transformations. Interpret relevant CAD Standards
21.	Unconventional Manufacturing Technology	Understand principles of material removal mechanism of advanced machining processes

		such as mechanical, electro-chemical processes
22.	Microelectromechanical Systems	Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process
23.	Industrial Safety	Evaluate the safety performance of an organization from accident records Study important legislations related to Health , Safety and Environment
24.	Industrial Robotics	Understand about robot configurations and drives Analyze the robot programming
25.	Total Quality Management	Analyze and Explain the Customer satisfaction, Employee involvement, supplier selection and appraise the performance by TQM principle
26.	Product Design and Development	Find the various product specifications and principles needed for the product development process. Understand the various techniques involved in the prototyping process
27.	Computer Integrated Manufacturing	Compare the system modeling tools in CIM and the fundamental concepts of data communications. Discuss the applications of database and system protocol
28.	Process Planning and Cost Estimation	Understand about material selection and Process planning and its factors , parameters Analyze various costs, allowances and machining time for various operations
29.	Composite Materials	Analyze various manufacturing methods of composite materials Understand the mechanical behaviour of Composite materials
30.	Automotive Electronics	Analyze the concepts of automotive electronic engine management system, dashboard and warning systems
	Minor courses	
31.	CNC Programming	CNC part programming and Hardware Analysis
32.	Pneumatics and Hydraulics	Sensors and actuators working anlysis
33.	Non Destructive Testing	Practical knowledge of Testing Techniques
	Other Departments	
46.	Human Ethics, Values, Rights And Gender Equality	-
47.	Cyber Security	Software and Hardware Security
48.	Constitution of India	New course

IV. VALUE ADDED COURSES SUGGESTED

1. AUTOCAD –Drafting
2. CREO-Software
3. CATIA-Software
4. MEP Engineering design –Mechanical Electrical and Plumbing design software
5. Non Destructive Testing
6. ANSYS Software

V. Activities with direct bearing on enhancing employability/skill development/ entrepreneurship

	Course Name	List of Activities
	Professional Core subjects	
1.	Manufacturing Technology	1.Jig design 2.Linear and angular measuring equipments principle of operation and applications 3. Solve linear programming problems .
2.	CAD CAM	2 day training on CAM simulation at CAD/CAM lab.
3.	Strength of Materials	1 day training course on 3D stress analysis in CAD systems. Activity: Creating stress distribution in mechanical components.
4.	Automation in Manufacturing	2 Day Industrial Visit on 3D printing
5.	Kinematics & Theory of Machines	Training on structural analysis
6.	Solid Mechanics	3 day training course on design and analysis software (ANSYS) Activity: Stress and deformation study on basic mechanical elements using ANSYS.
	Professional Elective subjects	
7.	Gas Dynamics and Shock Waves	Shock waves demonstration
8.	Power Plant Engineering	Mettur Dam visit
9.	Refrigeration and Air conditioning	Air Conditioning service training

10.	Renewable Energy Sources	Solar power generation and wind power generation demonstration
11.	Advanced I.C Engines	Smoke Test and engine performance test demonstration
12.	Energy Conservation and Management	Energy Audit Training
13.	Finite Element Analysis	Load and Structure analyses
14.	Design of Transmission Systems	Various Shaft and Gear drives mini project
15.	Mechanical Vibrations	Damping Characteristics Study
16.	Computational Fluid Dynamics	Flow analysis
17.	Machine Drawing	Assembly Drawing and part drawing analysis
18.	Design of Jigs and Fixtures and press tools	Design practices of various Jigs and Fixtures
19.	Mathematical Modeling and Analysis	Application of Modeling techniques
20.	Computer Aided Design	Geometric modeling analysis
21.	Unconventional Manufacturing Technology	NIT trichy visit-wire cut EDM and Laser Machining
22.	Microelectromechanical Systems	NIT trichy visit-Robotics
23.	Industrial Safety	Industry visit and safety measures
24.	Industrial Robotics	NIT trichy visit-Robotics
25.	Total Quality Management	Application of 5S principles
26.	Product Design and Development	Proto type model Development
27.	Computer Integrated Manufacturing	CNC and VMC Machine Hardware Interface Study
28.	Process Planning and Cost Estimation	Economical analysis
29.	Composite Materials	SEM analysis of Composite Materials
30.	Automotive Electronics	Study of sensors and actuators

	Other Departments	
33.	Human Ethics, Values, Rights And Gender Equality	Collection of details on conflict and arbitrations
34.	Constitution of India	Collection and compilation of various constitution law

Course articulation matrix

	C	P	A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	L:T:P:C
Core Subjects																		
XME302	3.5	0.25	0.25	8	-	2	7	9	-	6	5	6	5	-	9		15	**3:1:0:4**
XME303	3.5	0.25	0.25	15	15	10	15	15	5	10	5	10	5	12	15	10		**3:1:0:4**
XEM304	3.5	0.25	0.25	15	10	6	5	15	5	5	11	15	11	5	15	10		**3:1:0:4**
XME306	3	0	0	15	15	15	2	10	-	-	10	-	5	10	15	15		**3:0:0:3**
XUM305	2.7	0	0.3	5	10	14	5	0	15	5	7	15	9	12	12	5	5	**3:0:0:3**
XME401	3.5	0.25	0.25	13	13	5	3	3	0	0	8	15	0	15	15		15	**3:1:0:4**
XME402	3.5	0.25	0.25	15	10	3	10	6			3	5		5	5	10		**3:1:0:4**
XME404	3.5	0.25	0.25	15	15	6	7	15	5	4	9	10	10	4	8		10	**3:1:0:4**
XME405	3	0	0	13	12	9	11	5	2		6	10	13	10	11	10	5	**3:0:0:3**
XME406	3.5	0.25	0.25													5	5	**3:1:0:4**
XME502	3.5	0.25	0.25	13	12	14	9	5	4	3		3			5		10	**3:1:0:4**
XME503	3	0	0	15	15	10	15	15	5	15	5	5	10	10	15	10		**3:0:0:3**
XME504	3	0	0	15	11	10	15	12	5	15	5	6	13	11	15	15		**3:0:0:3**

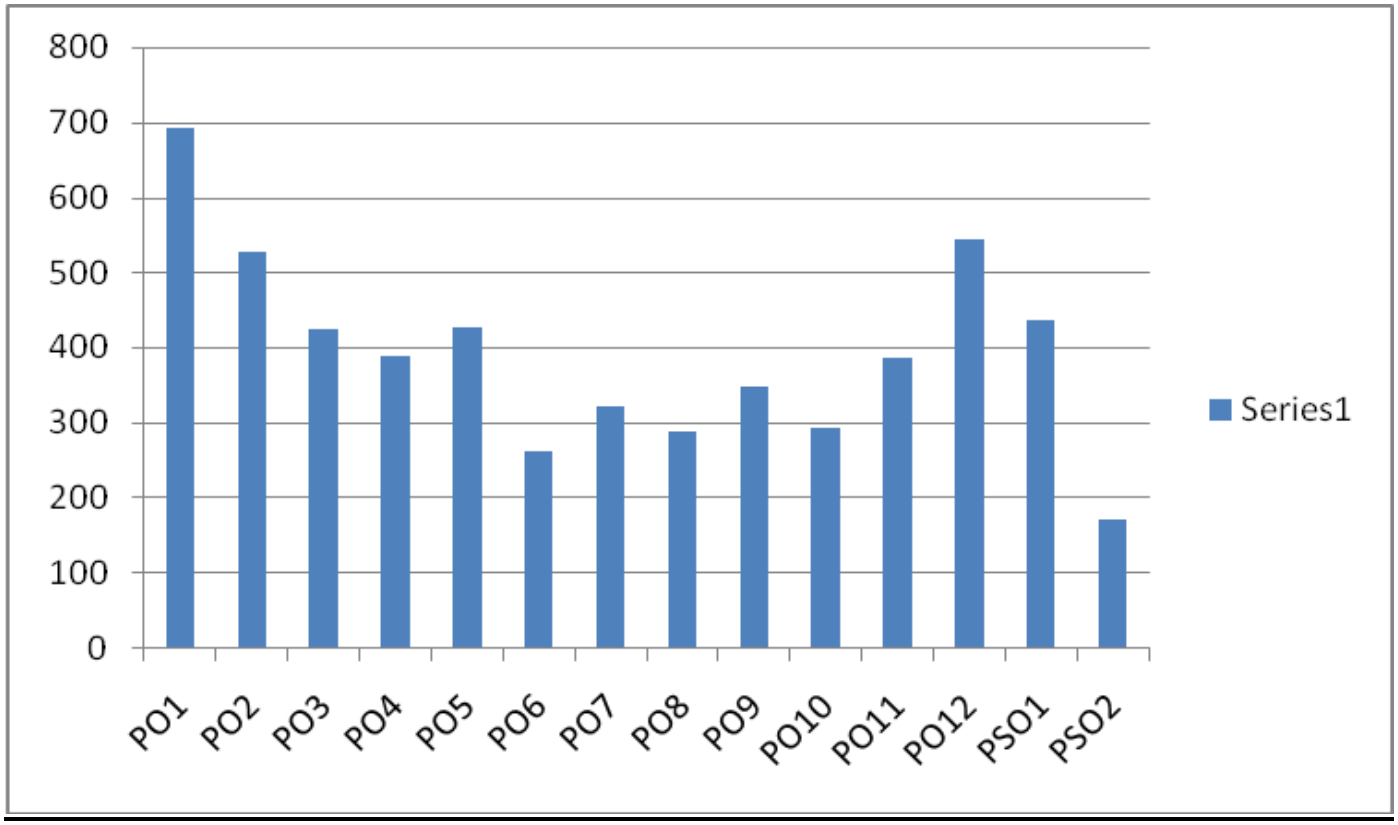
XME505	4	0	0	15	9	12	-	12	5	-	9	6	-	10	15	10		**3:1:0:4**
XME507	0	2	0	10	15	2	9	5	5			3			5		15	**0:0:2:2**
XME602	4	0	0	9	5			4	5	3	3				5	15		**4:0:0:4**
XME603	3	1	0	14	10	14	6	10	5	10	10	5	10	10	10	10		**3:1:0:4**
XME606	0	2	0	10	15	2	9	5	5			3			5	10		**0:0:4:2**
XME702	3	0	0	15	10	3	10	6			3	5		5	5	15		**3:0:0:3**
XME707	0	2	0	10	15	2	9	5	5			3			5	15		**0:0:4:2**
Professional Electives																		
XMEE01	3	0	0	14	4	-	8	13	-	8	-	-	7	6	11		15	**3:0:0:3**
XMEE02	3	0	0	13			9	9	8			7		1	3		15	**3:0:0:3**
XMEE03	3	0	0	13	11	7	1	4	5	1	9	11	6	12	12		15	**3:0:0:3**
XMEE04	3	0	0	13	11	7	1	4	5	1	9	11	6	12	12		15	**3:0:0:3**
XMEE05	3	0	0	9	7	8	7	5	4	3	2	2			5		15	**3:0:0:3**
XMEE06	3	0	0	9	7	8	7	5	4	3	2	2			5		15	**3:0:0:3**
XMEE07	3	0	0	15	9	14	4	14	4	5	-	5	4	9	13	10		**3:0:0:3**
XMEE08	3	0	0	15	10	15	0	5	0	10	5	10	5	10	15	10		**3:0:0:3**

XMEE09	3	0	0	15	15	10	15	15	5	15	5	5	10	10	15	10		**3:0:0:3**
XMEE10	3	0	0	14	4	-	6	13	-	5	-	-	7	6	11	10		**3:0:0:3**
XMEE11	3	0	0	15	15	15	6	15	6	15	5	5	6	11	15	10		**3:0:0:3**
XMEE12	3	0	0	15	15	10	15	15	5	15	10	5	10	12	15	10		**3:0:0:3**
XMEE13	3	0	0	10	10	10	3	5	1	10	5			10	10	10		**3:0:0:3**
XMEE14	3	0	0	15	13	15	10	12	11	11	12	11	10	10	13	10		**3:0:0:3**
XMEE15	3	0	0	14	15	10	9	8	7	10	10	6	8	14	13	15		**3:0:0:3**
XMEE16	3	0	0	6	5	10	5	5	10	6	5	5	5	6	5	15		**3:0:0:3**
XMEE17	3	0	0	6	5	10	5	5	10	6	5	5	5	6	5	15		**3:0:0:3**
XMEE18	3	0	0	-	3	-	8	3	3	6	-	4	2	5	5	15		**3:0:0:3**
XMEE19	3	0	0	10	10	12	8	9	12	1	10	6	10	11	11	10		**3:0:0:3**
XMEE20	3	0	0	6	2	6	11	6	7	12	5	6	12	13	12	10		**3:0:0:3**
XMEE21	3	0	0	6	2	6	11	6	7	12	5	6	12	13	12	15		**3:0:0:3**
XMEE22	3	0	0	6	2	6	11	6	7	12	5	6	12	13	12	10		**3:0:0:3**
XMEE23	3	0	0	15	12	11	12	8	7	9	9	9	5	7	10	10		**3:0:0:3**
XMEE24	3	0	0	4	11	9	8	11	7	10	8	7	5	12	8	10		**3:0:0:3**

XMEE25	3	0	0	15	4	7	5	5				7		2	5	10		**3:0:0:3**
Projects and Internship																		
XME307	0	2	0															**0:0:2:0**
XME508	0	2	0															**0:0:2:0**
XME709	0	4	0															**0:0:4:2**
XME708	0	8	0															**0:0:8:4**
XME804	0	12	0															**0:0:12:6**
Humanities and Social Sciences																		
XGS 103	2.6	0.4	0	7	0	0	0	0	0	6	0	4	0	0	0			**2:0:1:3**
Basic Sciences																		
XMA101	3	0.5	0.5	15	8	0	0	3	0	0	0	0	5	0	7			**3:1:0:4**
XAC104	3.5	1.0	0.5	19	0	0	0	0	0	10	13	14	0	0	0			**3:1:1:5**
XMA201	3	0.5	0.5	15	8	0	0	3	0	0	0	0	5	0	7			**3:1:0:4**
XAP204	2.8	0.8	0.4	15	6	9	6	4				3			5			**3:1:2:6**
XME301	3.5	0.25	0.25	15	10	5	3	2	2	1		5	5	2	5			3:1:0:4

Engineering Sciences																		
XCP 102	3	0.5	0.5	12	10	3	4	11			1		2	10	12	10		**3:0:2:5**
XWB105	1	3	0	10	5	10	10	5			5	5		5	10	15		**2:0:2:3**
XBE203	3	1	0	12	12	6	5	6	6	3	3	5	5	5				**3:1:1:5**
XEG205	1.75	1	0.25	15	15	15	6	15	6	15	5	5	6	11	15	15		**2:0:1:3**
XEM304	3.5	0.25	0.25	15	10	6	5	15	5	5	11	15	11	5	15	15		**3:1:0:4**
UGC Mandatory																		
XES202	1.4	0.3	0.3	10	3	6			11	4	3	2	2		5			**3:0:0:0**
XUM305	2.7	0	0.3	5	10	14	5	0	15	5	7	15	9	12	12			**3:0:0:3**
XUM403	3	0	0		2						13	3	4		2			**3:0:0:3**
XUM506	2	0	0															**2:0:0:0**
XUM706	3	0	0	15	10	6	13	0	5	10	2	5	0	5	5			**3:0:0:0**
Total				693	528	425	389	427	261	321	288	347	292	385	543	435	170	

Graph showing the cumulative POs for Eight semesters



Guidelines for UG Engineering & Technology Curriculum 2019-20

Curriculum Structure for B.Tech. (Full time) Degree Programmes offered by PMIST

Semester I

Branch	C1	C2	C3	C4	C5	C6	Credit
Aero	Chemistry And lab	Calculus and Linear Algebra	Basic Electrical Eng	Eng Graphics and Design			17.5
Bio	Chemistry	Calculus and Linear Algebra	Physics	English with lab/communication skills	Eng Graphics and Design	Physics lab	19.5
Civil	Physics: Mechanics of Solid and Lab	Calculus and Linear Algebra	Basic Electrical Engineering	Eng Graphics and Design			17.5
ECE	Physics Introduction to Electromagnetic theory and lab	Calculus and Linear Algebra	Basic Electrical Engg	Eng Graphics and Design		Essence of Indian traditional Knowledge	17.5
CSE	Physics Semiconductor And lab	Calculus and Linear Algebra	Basic Electrical Engg	Eng Graphics and Design			17.5
EEE	Physics Semi conductor	Calculus and Differential Equation	Programming for problem solving using C	English with Lab			17.5
Mech	Physics Electromagnetism And lab	Calculus and Linear Algebra	Basic Electrical Engg	Eng Graphics and Design			17.5
Nano	Physics Semiconductor	Calculus and Linear Algebra	Basic Electrical Engg	Eng Graphics and Design		Indian traditional Knowledge	17.5

Semester II

Branch	C1	C2	C3	C4	C5	C6	C7	CREDITS
Aero	Differential equations	Physics I Electromagnetism	Computer programming	Basic Electronics Engineering	English with Lab		Constitution of India	21.5
Bio	Calculus ODE Complex variables	Basic Electrical and Electronics Engineering	Programming for problem solving	Thermodynamics –I	Introduction to biotech	Chemistry lab		23.5
Civil	Diff Equations	Chemistry 1 With lab	Programming for prob	Workshop/Manufacturing Practices	English with Lab			20.5
ECE	Calculus ODE and Complex variables	Chemistry 1 and lab	Programming for problem solving	Workshop/Manufacturing Practices	English with Lab		Constitution of India	20.5
CSE	Probability and Statistics	Chemistry 1 And Lab	Programming for problem solving	Workshop/Manufacturing Practices	English with Lab			20.5
EEE	Linear Algebra, transform, calculus and numerical methods	Chemistry 1	Basic Electrical Engg.	Workshop/Manufacturing Practices	Engineering graphics			20.5
Mech	ODE & Compl	Chemistry 1 And lab	Programming for	Workshop/Manufacturing Practices	English with Lab		Constitution of	20.5

	ex variables		problem solving				India	
Nano	Calculus ODE Complex variables	Chemistry 1	Programming for prob	Workshop/Manufacturing Practices	English with Lab		Constitution of India	20.5

Semester III

Branch	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**Credits**
Aero	Physics 2: Optics and Waves	Maths III	Engineering Materials	Workshop practices	Eng Mechanics	Engineering thermodynamics				21
Bio	Material science	Chemistry 2	Cell biology	Biology	Princles of Chemical Engg	Eng workshop				23
Civil	Basic Electronics	Biology	CACD	Eng Mechanics	Energy Science and Engg	Life sciences	Maths 3 Trsnforms and discrete	Effective technical communication	Introduction to civil engg	22
ECE	Electronic devices	Electronic devices Lab	Digital systems design	Digital Sys Design Lab	Signals and Systems	Network theory	Slot for BS/ES/HS	Slot for MC		20
CSE	Analog Electronic circuits	Data structures and algorithms	Digital electronics	IT workshop (Scilab/ Matlab)	Differential calculus	Technical Communication with lab				23
EE	Electr	Analog	Analo	Electr	Electr	Electrom	Engin			20

E	ic ciruit analysis	Electronic c	g Electronc s Lab	ic machines 1	ical machines Lab	agnetic fields	eering Mechanics			
Mech	Physics 2: Optics and Wav	Maths 3 PDE Prob and Sta	Biology for engg	Basic Electronics Engg	Engineering Mechanics	Thermodynamics				23
Nano	Physics 2: Optics and Wav	Transformadn PDE	Biology for engg	Material Sciences	Introduction to Nano Tech	Interpersonal Communication				20

Semester IV

Branch	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**Credits**
Aero	PCC	PCC	PCC	PCC	PCC	Environ Studies (MC)					17.5
Bio	PCC	PCC	PCC	PCC	Maths 3	Environmental sciences (Mandatory)	Technical Communication skills				20
Civil	Mechanical Engg	PCC	PCC	PCC	PCC	PCC	PCC	PCC	Societal and Global Impact	Organization Behaviour	23
ECE	PCC	PCCLab	PCC	PCC Lab	PCC	PCC Lab	SLOT FOR BS/HS/ES				20
CSE	PCC DISCRET MATHS	PCC	PCC	PCC	Organizational behavior/ Finance accounting	EnvSci (MC)					22

EEE	Prob Statistics	PCC	PCC	PCC	PCC	PCC	PCC	PCC	Biology	MC	22
Mech	PCC	PCC	PCC	PCC	Material Enginee	PCC	Environ Sci				19
Nano	Princip of chemical engg	PCC	Eng Mechanics	Fluid Mechanics	Random Process						19

Semester V

Branch	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**Credits**
Aero	PCC	PCC	PCC	PCC	OE 1	PCC L	Essence of Indian tradition				17
Bio	PCC	PCC	PEC	OE 1	Entrpreneurship development	PCC	PCC	Constitution of India (MC)			21
Civil	PCC	PCC	PCC	PCC	PCC	PCC	PCC	Professional practice Law and Ethics	Constitution of India		23
ECE	PCC	PCC	PCC	PCC	PCC	PCC	PEC 1	OE 1			20
CSE	Signal and Systems	PCC	PCC	PCC	Entrepruership	PEC 1	Constitution of India				21
EEE	PCC	PCC	PCC	PCC	PCC	PCC	PEC1	OE1	Principles of Management		21
Mech	PCC	PCC	PCC	PCC	OE 1	PCC-lab	Essence of Indian	Proj 1			20.5

Nano	PCC	PCC	PCC	PEC 1	OE 1	Eng Thermodynamics	IPT 1				22

SEMESTER VI

Branch	C1	C2	C3	C4	C5	C6	C7	C8		Credits
Aero	PCC	PCC	PEC 1	PEC 2`	OE 2	PCC Lab	PCC Lab			18
Bio	PCC	PCC	PCC	PCC	PEC2	Bio Ethics and IPR	OE 2			20
Civil	PCC	PCC	PEC 1	PEC 2	OE1	PEC 3	PEC4			23
ECE	PCC	PCC	PCC	PCC	PEC 2	OE2	Slot BS/HS	MINI PROJ/ Electronic design workshop		20
CSE	PCC	PCC	PEC 2	PEC 3	OE 1	PROJ 1				22
EEE	PCC	PCC	PCC	PCC	PEC 2	PEC 3	OE2	SLOT FOR HS	SUMMER INTERNSHIP	22
Mech	PCC	PCC	PEC 1	PEC 2`	OE 2	PCC Lab	Proj-2			21.5
NANO	PCC	PCC	PEC 2	OE2	SURFACE ENGG	TQM	ACAD WRITI			22

Semester VII

Branch	C1	C2	C3	C4	C5	C6	C7	C8	Credits
Aero	PCC	PEC 3	PEC4E	OE3	PCC LAB		PROJ 1		18.5
Bio	PCC	PCC	PEC 3	PEC 4	OE 3	OE 4	IPT		18
Civil	PEC 5	PEC 6	OE 2	PRJ 1					15
ECE	PEC 3	PEC 4	PEC 5	OE 3	Slot BS/HS		PROFJ 1		21
CSE	PEC 4	PEC 5	OE 2	Biology	PROJ 2				18
EEE	PEC 4	PEC 5	OE 3	OE4	PROJ 1	SLOT FOR HS			18
Mech	PCC	PEC 3	PEC 4	OE3	PCC LAB	PROJ 3			18.5
NANO	PCC	PCC	PEC 3	PEC 4	OE 3	ENTREPRENU	IPT	PROJ 1	23

SEMESTER VIII

Branch	C1	C2	C3	C4	C5	C6	CREDITS
Aero	PEC 5	PEC 6	OE 4	OE 5	PROJ 2		18
Bio	PROJ2						12
Civil	PEC 7	PEC 8	OE 3	OE 4	PROJ 2		16
ECE	PEC 6	PEC 7	OE 4	OE 5	PROJ 2		21
CSE	PEC 6	OE 3	OE 4	PROJ 3			15
EEE	PEC 6	OE 5	OE 6	PROJ 2			17

Mech	PEC 5	PEC 6	OE 4	OE 5	PROJ 4		18
NANO	PCC	PCC	PEC 5	OE 4	OE 5	PROJ 2	20

Branch	C1	CREDITS
Nano – IX	**Proj 3**	**8**
Nano – X	**Proj 4**	**8**

B.TECH – FULL TIME- SYLLABUS

REGULATION – 2018 REVISION I (2019)

(Applicable to the students admitted from the Academic year 2019-20)

Semester	**I**
Subject Name	**Calculus and Linear Algebra**
Subject Code	**XMA101**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3:0.5:0.5**	**4- 1– 0 – 5**

Course Outcome		**Domain/Level C or P or A**
CO1	**Apply** orthogonal transformation to reduce quadratic form to canonical forms.	Cognitive (Remembering Applying)
CO2	**Apply** power series to tests the convergence of the sequences and series. Half range Fourier sine and cosine series.	Cognitive (Applying Remembering) Psychomotor(Guided Response)
CO3	**Find** the derivative of composite functions and implicit functions. Euler's theorem and Jacobian	Cognitive (Remembering) Psychomotor(Guided Response)
CO4	**Explain** the functions of two variables by Taylor's expansion, by finding maxima and minima with and without constraints using Lagrangian Method. Directional derivatives, Gradient, Curl and Divergence.	Cognitive(Remembering Understanding) Affective(Receiving)
CO5	**Apply** Differential and Integral calculus to notions of Curvature and to improper integrals.	Cognitive (Applying)

Objective

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

COURSE CONTENT

UNIT I Matrices 15 hrs

Linear Transformation - Eigen values and Eigen vectors -Properties of Eigen values and Eigen vectors - Cayley-Hamilton Theorem – Diagonalisation of Matrices – Real Matrices: Symmetric - Skew-Symmetric and Orthogonal Quadratic form – canonical form - Nature of Quadratic form and Transformation of Quadratic form to Canonical

form (Orthogonal only).

UNIT II	Sequences and series	15 hrs

Sequences: Definition and examples-Series: Types and convergence- Series of positive terms – Tests of convergence: comparison test, Integral test and D'Alembert's ratio test-Fourier series: Half range sine and cosine series- Parseval's Theorem.

UNIT III	Multivariable Calculus: Partial Differentiation	15 hrs

Limits and continuity –Partial differentiation – Total Derivative – Partial differentiation of Composite Functions: Change of Variables – Differentiation of an Implicit Function - Euler's Theorem- Jacobian.

UNIT IV	Multivariable Calculus: Maxima and Minima and Vector Calculus	15 hrs

Taylor's theorem for function of Two variables- Maxima, Minima of functions of two variables: with and without constraints - Lagrange's Method of Undetermined Multipliers – Directional Derivatives - Gradient, Divergence and Curl.

UNIT V	Differential and Integral Calculus	15 hrs

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

L = 60 hrs T = 15 hrs P=0 hrs Total = 75 hrs

TEXT BOOKS

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2015**. (Unit-1, Unit-3 and Unit-4).**
2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2014. **(Unit-2).**
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition, 2010. **(Unit-5).**

REFERENCES

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
2. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/Cole, 2005.
4. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

E-REFERENCES

1. http://nptel.ac.in/faq/110101010/Prof.IndrajitMukherjee,IIT,Bombay and Prof. Tapan P.Bagchi, IIT, Kharagpur.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**PROGRAMMING FOR PROBLEM SOLVING**
Subject Code	**XCP102**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 2– 5	**3:0.5:0.5**	**3- 0– 4 – 7**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define*** programming fundamentals and ***Solve*** simple programs using I/O statements	Cognitive (Remember Understand, Apply) Psychomotor
CO2	***Define*** syntax and ***write simple programs*** using control structures and arrays	Cognitive (Remember Understand,Apply) Psychomotor
CO3	***Explain*** and ***write simple programs*** using functions and pointers	Cognitive (Understand, Apply) Psychomotor
CO4	***Explain*** and ***write simple programs*** using structures and unions	Cognitive (Understand Apply,Analyze) Psychomotor

CO5	***Explain*** and ***write simple programs*** using files and ***Build*** simple projects	Cognitive (Remember Understand, Create) Psychomotor

COURSE CONTENT

UNIT I	**PROGRAMMING FUNDAMENTALS AND INPUT /OUTPUT STATEMENTS**	**9+6 hrs**

Theory

Introduction to components of a computer system, Program – Flowchart – Pseudo code – Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, and Operators – sample program structure - Header files – Data Types-Variables - Output statements – Input statements.

Practical

1. Program to display a simple picture using dots.
2. Program for addition of two numbers
3. Program to swap two numbers
4. Program to solve any mathematical formula.

UNIT II	**CONTROL STRUCTURE AND ARRAYS**	**9+6 hrs**

Theory

Control Structures – Conditional Control statements: Branching, Looping - Unconditional control structures: switch, break, continue, goto statements – Arrays: One Dimensional Array – Declaration – Initialization – Accessing Array Elements – Searching – Sorting – Two Dimensional arrays - Declaration – Initialization – Matrix Operations – Multi Dimensional Arrays - Declaration – Initialization. Storage classes: auto – extern – static. Strings: Basic operations on strings.

Practical

1. Program to find greatest of 3 numbers using Branching Statements
2. Program to display divisible numbers between n1 and n2 using looping Statement
3. Program to remove duplicate element in an array.
4. Program to perform string operations.
5. Performing basic sorting algorithms

UNIT III	**FUNCTIONS AND POINTERS**	**9+6 hrs**

Theory

Functions: Built in functions – User Defined Functions - Parameter passing methods - Passing arrays to functions – Recursion - Programs using arrays and functions. Pointers - Pointer declaration - Address operator - Pointer

expressions & pointer arithmetic - Pointers and function - Call by value - Call by Reference - Pointer to arrays - Use of Pointers in self-referential structures-Notion of linked list(no implementation).

Practical

1. Program to find factorial of a given number using four function types.
2. Programs using Recursion such as Finding Factorial, Fibonacci series,

   Ackerman function etc. Quick sort or Merge sort
3. Programs using Pointers

UNIT IV STRUCTURES AND UNIONS 9+6 hrs

Theory

Structures and Unions - Giving values to members - Initializing structure - Functions and structures - Passing structure to elements to functions - Passing entire function to functions - Arrays of structure - Structure within a structure and Union.

Practical

1. Program to read and display student mark sheet Structures with variables
2. Program to read and display student marks of a class using Structures with arrays
3. Program to create linked list using Structures with pointers

UNIT V FILES 9+6 hrs

Theory

File management in C - File operation functions in C - Defining and opening a file - Closing a file - The getw and putw functions - The fprintf & fscanf functions - fseek function – Files and Structures.

Practical

1. Program for copying contents of one file to another file.
2. Program using files using structure with pointer

L = 45 hrs T = 0 hrs P=30 hrs Total = 75 hrs

TEXT BOOKS / REFERENCES

1. Byron Gottfried, "Programming with C", III Edition, (Indian Adapted Edition), TMH publications, 2010

2. Yeshwant Kanethker, “Let us C”, BPB Publications, 2008

3. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education Inc. 2005

4. Behrouz A. Forouzan and Richard. F. Gilberg, "A Structured Programming Approach Using C", II Edition, Brooks–Cole Thomson Learning Publications, 2001

5. Johnson baugh R. and Kalin M., “Applications Programming in ANSI C”, III Edition, Pearson Education India, 2003

6. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

E-REFERENCES

1. http://nptel.ac.in/faq/110101010/Prof.IndrajitMukherjee,IIT,Bombay and Prof. Tapan P.Bagchi, IIT, Kharagpur.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO 12	PS O1	PS O2
CO1	3	2			3						2	3	2	
CO2	3	2			2						2	3	2	
CO3	2	2	1	2	2						2	2	2	
CO4	2	2	1	2	2						2	2	2	
CO5	2	2	1		2			1		2	2	2	2	
Total	**12**	**10**	**3**	**4**	**11**			**1**		**2**	**10**	**12**	**10**	

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**English**
Subject Code	**XGS103**

L –T –P –C	**C:P:A**	**L –T –P –H**
2- 0 – 1– 3	**2.6:0.4:0**	**2- 0– 2 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Ability*** to recall the meaning for proper usage	Cognitive (Remembering)

CO2	***Apply*** the techniques in sentence patterns	Cognitive (Applying)
CO3	***Identify*** the common errors in sentences	Cognitive (Remembering)
CO4	***Construct*** the Nature and Style of sensible Writing	Cognitive(Creating)
CO5	***Practicing*** the writing skills	Psychomotor (Guided response)
CO6	***Grasping*** the techniques in learning sounds and etiquettes	Psychomotor (Adapting)

COURSE CONTENT

UNIT I	**Vocabulary Building**	**9 hrs**

1.1 The concept of Word Formation

1.2 Root words from foreign languages and their use in English

1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form

derivatives

1.4 Synonyms, antonyms, and standard abbreviations.

UNIT II	**Basic Writing Skills**	**9 hrs**

2.1 Sentence Structures

2.2 Use of phrases and clauses in sentences

2.3 Importance of proper punctuation

2.4 Creating coherence

2.5 Organizing principles of paragraphs in documents

2.6 Techniques for writing precisely

UNIT III	**Identifying Common Errors in Writing**	**9 hrs**

3.1 Subject-verb agreement

3.2 Noun-pronoun agreement

3.3 Misplaced modifiers

3.4 Articles

3.5 Prepositions

3.6 Redundancies

3.7 Clichés

UNIT IV	**Nature and Style of sensible Writing**	**9 hrs**

4.1 Describing

4.2 Defining

4.3 Classifying

4.4 Providing examples or evidence

4.5 Writing introduction and conclusion

UNIT V	**Writing Practices**	**9 hrs**

5.1 Comprehension

5.2 Précis Writing

5.3 Essay Writing

UNIT VI **Oral Communication**

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

L = 30 hrs T = 0 hrs P=15 hrs Total = 45 hrs

Suggested Readings

(i) Practical English Usage. Michael Swan. OUP. 1995

(ii) Remedial English Grammar. F.T. Wood. Macmillan.2007

(iii) On Writing Well. William Zinsser. Harper Resource Book. 2001

(iv) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006

(v) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011

(vi) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Mapping of Cos with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO 2	2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO 3	1	0	0	0	0	0	1	0	1	0	0	0	0	0
CO 4	2	0	0	0	0	0	1	0	1	0	0	0	0	0
CO 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot al	7	0	0	0	0	0	6	0	4	0	0	0	0	0

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**Applied Chemistry for Engineers**
Subject Code	**XAC104**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 1– 5	**3.5:1.0:0.5**	**3- 1– 2 – 6**

Course Outcome		**Domain/Level C or P or A**
CO1	***Identify*** the periodic properties such as ionization energy, electron affinity, oxidation states and electro negativity. ***Describe*** the various water quality parameters like hardness and alkalinity.	Cognitive (Remembering) Psychomotor(Perception)
CO2	***Explain*** *and* ***Measure*** microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces.	Cognitive (Understanding) Psychomotor(Set)
CO3	***Interpret*** bulk properties and processes using thermodynamic and kinetic considerations.	Cognitive(Applying) Psychomotor(Mechanism) Affective(Receive)
CO4	***Describe, Illustrate*** *and* ***Discuss*** the chemical reactions that	Cognitive(Remembering

	are used in the synthesis of molecules.	Analyzing) Psychomotor(Perception) Affective(Responding)
CO5	***Apply, Measure*** and ***Distinguish*** the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	Cognitive (Remembering, Applying) Psychomotor(Mechanism)

COURSE CONTENT

UNIT I	**PERIODIC PROPERTIES AND WATER CHEMISTRY**	**8+3+6 hrs**

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries. **Water Chemistry**-Water quality parameters-Definition and explanation of hardness, determination of hardness by EDTA method-Introduction to alkalinity.

UNIT II	**USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA**	**12+3+6 hrs**

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Corrosion-Types, factors affecting corrosion rate and Control methods. Use of free energy considerations in metallurgy through Ellingham diagrams. Advantages of electroless plating, electroless plating of nickel and copper on Printed Circuit Board (PCB).

UNIT III	**ATOMIC AND MOLECULAR STRUCTURE**	**10+3+6 hrs**

Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles.. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic molecules. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Intermolecular forces and potential energy surfaces

Ionic, dipolar and Vander waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

UNIT IV	**SPECTROSCOPIC TECHNIQUES AND APPLICATIONS**	**7+3+6 hrs**

Principles of spectroscopy and selection rules. Electronic spectroscopy-chromophore, auxochromes, types of electronic transition and application. Fluorescence and its applications in medicine. Vibrational spectroscopy-types of vibrations, Instrumentation and applications. Rotational spectroscopy of diatomic molecules. Nuclear magnetic resonance spectroscopy-concept of chemical shift and applications-magnetic resonance imaging. Diffraction and scattering.

UNIT V	**STEREOCHEMISTRY AND ORGANIC REACTIONS**	**8+3+6 hrs**

Representations of 3 dimensional structures, structural isomers and stereoisomers,

configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Organic reactions and synthesis of a drug molecule

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization reactions and ring opening reactions. Synthesis of a commonly used drug molecule- Aspirin and paracetamol.

L = 45 hrs T = 15 hrs P=30 hrs Total = 90 hrs

TEXT BOOKS

1. Puri B.R. Sharma, L.R., Kalia K.K. Principles of Inorganic Chemistry, (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., 1993
2. Lee. J.D. Concise Inorganic Chemistry, UK, Black well science, 2006.
3. Trapp. C, Cady, M. Giunta. C, Atkins's Physical Chemistry, 10th Edition, Oxford publishers, 2014.
4. Glasstone S., Lewis D., Elements of Physical Chemistry, London, Mac Millan & Co. Ltd, 1983.
5. Morrison R.T. and Boyd R.N. Organic Chemistry (6th edition), New York, Allyn & Bacon Ltd., 1976.
6. Banwell. C.N, Fundamentals of Molecular Spectroscopy, (3th Edition), McGraw-Hill Book Company, Europe 1983.
7. Bahl B.S. and Arun Bahl, Advanced Organic Chemistry, (4th edition), S./ Chand & Company Ltd. New Delhi, 1977.
8. P. S. Kalsi, Stereochemistry: Conformation and mechanism, (9th Edition), New Age International Publishers, 2017.

REFERENCES

1. Puri B R Sharma L R and Madan S Pathania, " Principles of Physical Chemistry", Vishal publishing Co., Edition 2004
2. Kuriocose, J C and Rajaram, J, "Engineering Chemistry", Volume I/II, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 2000

E-REFERENCES

1. http://www.mooc-list.com/course/chemistry-minor-saylororg
2. https://www.canvas.net/courses/exploring-chemistry
3. http://freevideolectures.com/Course/2263/Engineering-Chemistry-I
4. http://freevideolectures.com/Course/3001/Chemistry-I
5. http://freevideolectures.com/Course/3167/Chemistry-II
6. http://ocw.mit.edu/courses/chemistry/

Laboratory Part **30 hrs**

Experiments :

1. Determination of chloride ion present in the water sample by Argentometric method. **CO1**

2. Determination of total, temporary and permanent hardness of water sample by EDTA method.	**CO1**
3. Determination of cell constant and conductance of solutions.	**CO2**
4. Potentiometry - determination of redox potentials and emfs.	**CO2**
5. Determination of surface tension and viscosity.	**CO3**
6. Adsorption of acetic acid by charcoal.	**CO3**
7. Determination of the rate constant of a reaction.	**CO4**
8. Estimation of iron by colorimetric method.	**CO4**
9. Synthesis of a polymer/drug.	**CO5**
10. Saponification/acid value of oil.	**CO5**

REFERENCE BOOKS

1. Mendham, Denney R.C,. Barnes J.D and Thomas N.J.K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th Edition, Pearson Education, 2004.
2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. "Experiments in Physical Chemistry", 8 McGraw-Hill: New York, 2003.

E Resources - MOOCs:

1.http://freevideolectures.com/Course/2380/Chemistry-Laboratory-Techniques

2. http://freevideolectures.com/Course/2941/Chemistry-1A-General-Chemistry-Fall-2011

3.http://ocw.mit.edu/courses/chemistry/5-301-chemistry-laboratory-techniques

Mapping of COs with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO 1	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO 2	2	0	0	0	0	0	1	2	2	0	0	0	0	0
CO 3	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO 4	8	0	0	0	0	0	3	3	3	0	0	0	0	0
CO	3	0	0	0	0	0	2	2	3	0	0	0	0	0

5														
Total	19	0	0	0	0	0	10	13	14	0	0	0	0	0

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**Workshop Practices**
Subject Code	**XWP105**

L –T –P –C	**C:P:A**	**L –T –P –H**
2- 0 – 2– 3	**1:3:0**	**2- 0– 4 – 6**

Course Outcome		**Domain/Level C or P or A**
CO1	***Summarize*** the machining methods and ***Practice*** machining operation.	Cognitive (Understand) Psychomotor (Guided Response)
CO2	***Defining*** metal casting process, moulding methods and **relates** Casting and Smithy applications.	Cognitive (Remember) Psychomotor(Perception)
CO3	***Plan*** basic carpentry and fitting operation and ***Practice*** carpentry and fitting operations.	Cognitive (Apply) Psychomotor (Guided Response)
CO4	***Summarize*** metal joining operation and ***Practice*** welding operation.	Cognitive (Understand) Psychomotor(Guided Response)
CO5	***Illustrate*** the, electrical and electronics basics and ***Makes*** appropriate connections**.**	Cognitive (Understand) Psychomotor (Origination)

COURSE CONTENT

EXP.NO	**TITLE**	**CO RELATION**
1	Introduction to machining process	CO1
2	Plain turning using lathe operation	CO1
3	Introduction to CNC	CO1

4	Demonstration of plain turning using CNC	CO1
5	Study of metal casting operation	CO2
6	Demonstration of moulding process	CO2
7	Study of smithy operation	CO2
8	Study of carpentry tools	CO3
9	Half lap joint – Carpentry	CO3
10	Mortise and Tenon joint – Carpentry	CO3
11	Study of fitting tools	CO3
12	Square fitting	CO3
13	Triangular fitting	CO3
14	STUDY OF WELDING TOOLS	CO4
15	Square butt joint – welding	CO4
16	Tee joint – Welding	CO4
17	Introduction to house wiring	CO5
18	One lamp controlled by one switch	CO5
19	Two lamps controlled by single switch	CO5
20	Staircase wiring	CO5

TEXT BOOKS

1. Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay

2. Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.

REFERENCES

1. Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.

2. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd.,New Delhi

3. Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.

4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

E RESOURCES

1. **http://nptel.ac.in/courses/112107145/**

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO 12	PS O1	PS O2
CO1	2	1	2	2	1			1	1		1	2	3	
CO2	2	1	2	2	1			1	1		1	2	3	
CO3	2	1	2	2	1			1	1		1	2	3	
CO4	2	1	2	2	1			1	1		1	2	3	
CO5	2	1	2	2	1			1	1		1	2	3	
Total	**10**	**5**	**10**	**10**	**5**			**5**	**5**		**5**	**10**	**15**	

1 - Low, 2 – Medium, 3- High

Semester	**II**
Subject Name	**Calculus, Ordinary Differential Equations and Complex Variable**
Subject Code	**XMA201**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3:0.5:0.5**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	**Find** double and triple integrals and to find line, surface and volume of an integral by **Applying** Greens, Gauss divergence and Stokes theorem.	Cognitive (Remember, Apply)
CO2	**Solve** first order differential equations of different types Which are solvable for p, y, x and Clairaut's type.	Cognitive(Apply)
CO3	**Solve** Second order ordinary differential equations with Variable coefficients using various methods.	Cognitive(Apply)
CO4	**Use** CR equations to verify analytic functions and to find Harmonic functions and harmonic conjugate. Conformal mapping of translation and rotation. Mobius transformation.	Cognitive (Remember, Apply) Psychomotor(Guided Response)
CO5	**Apply** Cauchy residue theorem to evaluate contour	Cognitive(Apply)

	integrals involving sine and cosine function and to state	Affective(Receiving)
	Cauchy integral formula, Liouvilles theorem.	
	Taylor's series, zeros of analytic functions, singularities, Laurent's series.	

OBJECTIVES OF THIS COURSE:

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

COURSE CONTENT

UNIT I	**Multivariable Calculus (Integration)**	**12 hrs**
	Multiple Integration: Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Triple integrals (Cartesian), Scalar line integrals - vector line integrals - scalar surface integrals - vector surface integrals - Theorems of Green, Gauss and Stokes.	
UNIT II	**First order ordinary differential equations**	**12 hrs**
	Exact - linear and Bernoulli's equations - Euler's equations - Equations not of first degree: equations solvable for p - equations solvable for y- equations solvable for x and Clairaut's type.	
UNIT III	**Ordinary differential equations of higher orders**	**12 hrs**
	Second order linear differential equations with variable coefficients- method of variation of parameters - Cauchy-Euler equation- Power series solutions- Legendre polynomials- Bessel functions of the first kind and their properties.	
UNIT IV	**Complex Variable – Differentiation**	**12 hrs**
	Differentiation-Cauchy-Riemann equations- analytic functions-harmonic functions-finding harmonic conjugate- elementary analytic functions (exponential, trigonometric, logarithm) and their properties- Conformal mappings- Mobius transformations and their properties.	
UNIT V	**Complex Variable – Integration**	**12 hrs**
	Contour integrals - Cauchy-Goursat theorem (without proof) - Cauchy Integral formula (without proof)-Liouville's theorem (without proof)- Taylor's series- zeros of analytic functions- singularities- Laurent's series – Residues- Cauchy Residue theorem (without proof)- Evaluation of definite integral involving sine and cosine- Evaluation of certain improper integrals using the Bromwich contour.	

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40thth Edition, 2008.

REFERENCES

1.G.B. Thomas and R.L. Finney, “Calculus and Analytic geometry”, 9th Edition, Pearson, Reprint, 2002.

2. Erwin kreyszig, “Advanced Engineering Mathematics”, 9th Edition, John Wiley & Sons, 2006.

3.W. E. Boyce and R. C. DiPrima, “Elementary Differential Equations and Boundary Value Problems”, 9thEdn. Wiley India, 2009.

4. S. L. Ross, “Differential Equations”, 3rd Ed., Wiley India, 1984.

5.E. A. Coddington, “An Introduction to Ordinary Differential Equations”, Prentice Hall India, 1995.

6. E. L. Ince, “Ordinary Differential Equations”, Dover Publications, 1958.

7.J. W. Brown and R. V. Churchill, “Complex Variables and Applications”, 7th Ed., McGraw Hill, 2004.

8. N.P. Bali and Manish Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, Reprint, 2008.

E-REFERENCES

1. http://nptel.ac.in/faq/110101010/Prof.IndrajitMukherjee,IIT,Bombay and Prof. Tapan P.Bagchi, IIT, Kharagpur.

Mapping of COs with PO

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7

1 - Low, 2 – Medium, 3- High

Semester	**II**
Subject Name	**ENVIRONMENTAL SCIENCES**
Subject Code	**XES202**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 0	**1.4:0.3:0.3**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Describe*** the significance of natural resources and ***explain*** anthropogenic impacts.	Cognitive (Remember, Understand)
CO2	***Illustrate*** the significance of ecosystem, biodiversity and natural geo bio chemical cycles for maintaining ecological balance.	Cognitive(Understand)
CO3	***Identify*** the facts, consequences, preventive measures of major pollutions and ***recognize*** the disaster phenomenon	Cognitive(Remember) Affective(Receive)
CO4	***Explain*** the socio-economic, policy dynamics and ***practice*** the control measures of global issues for sustainable development.	Cognitive (Understand, Apply)
CO5	***Recognize*** the impact of population and the concept of various welfare programs, and ***apply*** the modern technology towards environmental protection.	Cognitive(Apply, Analyze)

COURSE CONTENT

UNIT I	**INTRODUCTION TO ENVIRONMENTAL STUDIES AND ENERGY**	**12 hrs**

Definition, scope and importance – Need for public awareness – Forest resources: Use, deforestation, case studies. – Water resources: Use and over-utilization of surface and ground water, dams-benefits and problems – Mineral resources: Uses, environmental effects of mining, case studies-iron mining(Goa), bauxite mining(Odisha) – Food resources: effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies – Land resources: Land as a resource, land degradation – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

UNIT II	**ECOSYSTEMS AND BIODIVERSITY**	**7 hrs**

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Biogeochemical cycles – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT III	ENVIRONMENTAL POLLUTION	10 hrs

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management– Role of an individual in prevention of pollution – Pollution case studies – Disaster management: flood, earthquake, cyclone and landslide.

UNIT IV	SOCIAL ISSUES AND THE ENVIRONMENT	10 hrs

Rain water harvesting – Resettlement and rehabilitation of people; its problems and concerns, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents – Consumerism and waste products – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Public awareness.

UNIT V	HUMAN POPULATION AND THE ENVIRONMENT	6 hrs

Population growth, variation among nations – Population explosion– Environment and human health – HIV / AIDS– Role of Information Technology in Environment and human health.

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

TEXT BOOKS

1.Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co, USA, 2000.

2. Townsend C., Harper J and Michael Begon, Essentials of Ecology, Blackwell Science, UK, 2003.

3. Trivedi R.K and P.K.Goel, Introduction to Air pollution, Techno Science Publications, India, 2003.

4. Disaster mitigation, Preparedness, Recovery and Response, SBS Publishers & Distributors Pvt. Ltd, New Delhi, 2006.

5. Introduction to International disaster management, Butterworth Heinemann, 2006.

6. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, New Delhi, 2004.

REFERENCES

1. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media, India, 2009.
2. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
3. S.K.Dhameja, Environmental Engineering and Management, S.K.Kataria and Sons, New Delhi, 2012.
4. Sahni, Disaster Risk Reduction in South Asia, PHI Learning, New Delhi, 2003.
5. Sundar, Disaster Management, Sarup & Sons, New Delhi, 2007.
6. G.K.Ghosh, Disaster Management, A.P.H.Publishers, New Delhi, 2006.

E-REFERENCES

1. http://www.e-booksdirectory.com/details.php?ebook=10526
2. https://www.free-ebooks.net/ebook/Introduction-to-Environmental-Science
3. https://www.free-ebooks.net/ebook/What-is-Biodiversity
4. https://www.learner.org/courses/envsci/unit/unit_vis.php?unit=4
5. http://bookboon.com/en/pollution-prevention-and-control-ebook

6. http://www.e-booksdirectory.com/details.php?ebook=8557
7. http://www.e-booksdirectory.com/details.php?ebook=6804
8. http://bookboon.com/en/atmospheric-pollution-ebook
9. http://www.e-booksdirectory.com/details.php?ebook=3749
10. http://www.e-booksdirectory.com/details.php?ebook=2604
11. http://www.e-booksdirectory.com/details.php?ebook=2116
12. http://www.e-booksdirectory.com/details.php?ebook=1026
13. http://www.faadooengineers.com/threads/7894-Environmental-Science

Mapping of COs with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3											1
CO2	2					2	1			1		1
CO3	2	1	3			3	1		2	1		1
CO4	1	1	2			3	2	3				1
CO5	2	1	1			3						1
Total	**10**	**3**	**6**			**11**	**4**	**3**	**2**	**2**		**5**

1 - Low, 2 – Medium, 3- High

Semester	**II**	
Subject Name	**Electrical and Electronic Engineering Systems**	
Subject Code	**XBE203**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 1– 5	**3:1:0**	**3- 2– 2 – 7**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define, Relate,*** the fundamentals of electrical parameters and ***build*** and ***explain*** AC, DC circuits by Using measuring devices	Cognitive(Remember, Understand) Psychomotor(Mechanism, Set)
CO2	***Define and Explain*** of operation of DC and AC machines.	Cognitive (Remember Understand)

CO3	***Recall and Illustrate*** various semiconductor devices and their applications and displays the input output characteristics of basic semiconductor devices.	Cognitive (Remember, Understand) Psychomotor(Mechanism)
CO4	***Relate and Explain*** the number systems and logic gates. ***Construc***t the different digital circuit.	Cognitive(Remember, Understand) Psychomotor(Origination)
CO5	***Label and Outline*** the different types of microprocessors and their applications.	Cognitive (Remember Understand)

The objective of this course

To provide an overview of electrical and electronic device components to Mechanical engineering students

COURSE CONTENT

UNIT I	**FUNDAMENTAL OF DC AND AC CIRCUITS, MEASUREMENTS**	**9+9+12 hrs**
	Fundamentals of DC– Ohm's Law – Kirchoff's Laws - Sources - Voltage and Current relations –Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities - Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter).	
UNIT II	**ELECTRICAL MACHINES**	**9+6+0 hrs**
	Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC motors - Basics of Single Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single Phase Transformer, Three phase transformers, Auto transformer.	
UNIT III	**SEMICONDUCTOR DEVICES**	**9+3+8 hrs**
	Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode – Zener Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications.	
UNIT IV	**DIGITAL ELECTRONICS**	**9+6+10 hrs**
	Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.	
UNIT V	**MICROPROCESSORS**	**9+6+0 hrs**
	Architecture, 8085, 8086 - Interfacing Basics: Data transfer concepts – Simple Programming concepts	

L = 45 hrs T = 35 hrs P=35 hrs Total = 105 hrs

	LIST OF EXPERIMENTS :
1.	Study of Electrical Symbols, Tools and Safety Precautions, Power Supplies.
2.	Study of Active and Passive elements – Resistors, Inductors and Capacitors, Bread Board.
3.	Verification of AC Voltage, Current and Power in Series and Parallel connection.
4.	Testing of DC Voltage and Current in series and parallel resistors which are connected breadboard by using Voltmeter, Ammeter and Multimeter.
5.	Fluorescent lamp connection with choke.
6.	Staircase Wiring.
7.	Forward and Reverse bias characteristics of PN junction diode.
8.	Forward and Reverse bias characteristics of zener diode.
9.	Input and Output Characteristics of NPN transistor.
10.	Construction and verification of simple Logic Gates.
11.	Construction and verification of adders.
12.	Construction and verification of subtractor.

TEXT BOOKS

1. Metha V.K., 2008. Principles of Electronics. Chand and Company.

2. Malvino, A. P., 2006. Electronics Principles. 7th ed. New Delhi: Tata McGraw-Hill.

3. Rajakamal, 2007. Digital System-Principle & Design. 2nd ed. Pearson education.

4. Morris Mano, 1999. Digital Design. Prentice Hall of India.

5. Ramesh, S. Gaonkar, 2000. Microprocessor Architecture, Programming and its Applications with the 8085. 4th ed. India: Penram International Publications.

REFERENCES

1. Corton,H.,2004. Electrical Technology. CBS Publishers & Distributors.

2. Syed, A. Nasar, 1998, Electrical Circuits. Schaum Series.

3. Jacob Millman and Christos, C. Halkias, 1967. Electronics Devices.New Delhi: McGraw-Hill.

4. Millman, J. andHalkias, C. C., 1972. Integrated Electronics: Analog and Digital Circuits and Systems. Tokyo: McGraw-Hill, Kogakusha Ltd.

5. Mohammed Rafiquzzaman, 1999. Microprocessors - Theory and Applications: Intel and Motorola. Prentice Hall International.

E-REFERENCES

1. NTPEL, Basic Electrical Technology (Web Course), Prof. N. K. De, Prof. T. K. Bhattacharya and Prof. G. D. Roy, IIT Kharagpur.

2. Prof.L.Umanand, http://freevideolectures.com/Course/2335/Basic-Electrical-Technology#, IISc Bangalore.

3. http://nptel.ac.in/Onlinecourses/Nagendra/, Dr. Nagendra Krishnapura , IIT Madras.

4. Dr.LUmanand , http://www.nptelvideos.in/2012/11/basic-electrical-technology.html, IISC Banglore.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO 12
CO1	3	3	1	1	1	1			1	1	1	
CO2	3	3	1	1	1	1			1	1	1	
CO3	2	2	2	1	2	2	1	1	1	1	1	
CO4	2	2	1	1	1	1	1	1	1	1	1	
CO5	2	2	1	1	1	1	1	1	1	1	1	
Total	12	12	6	5	6	6	3	3	5	5	5	

1 - Low, 2 – Medium, 3- High

Semester	**II**
Subject Name	**Applied Physics for Engineers**
Subject Code	**XAP204**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 2– 6	**2.8:0.8:0.4**	**3- 1– 4 – 8**

Course Outcome		**Domain/Level C or P or A**
CO1	***Identify*** the basics of mechanics, ***explain*** the principles of elasticity and ***determine*** its significance in engineering systems and technological advances.	Cognitive(Remember, Understand) Psychomotor(Mechanism)
CO2	***Illustrate*** the laws of electrostatics, magneto-statics and electromagnetic induction; ***use*** and ***locate*** basic applications of electromagnetic induction to technology.	Cognitive (Remember, Analyze)

		Psychomotor (Mechanism) Affective (Respond)
CO3	***Understand*** the fundamental phenomena in optics by measurement and ***describe*** the working principle and application of various lasers and fibre optics.	Cognitive (Understand, Apply) Psychomotor(Mechanism) Affective (Receive)
CO4	***Analyse*** energy bands in solids, ***discuss*** and ***use*** physics principles of latest technology using semiconductor devices.	Cognitive(Understand, Analyze) Psychomotor(Mechanism) Affective (Receive)
CO5	***Develop*** Knowledge on particle duality and ***solve*** Schrodinger equation for simple potential.	Cognitive (Understand, Apply)

COURSE CONTENT

UNIT I	**MECHANICS OF SOLIDS**	**9+3+9 hrs**
	Mechanics: Force - Newton's laws of motion - work and energy - impulse and momentum - torque - law of conservation of energy and momentum - Friction. **Elasticity:** Stress - Strain - Hooke's law - Stress strain diagram - Classification of elastic modulus - Moment, couple and torque - Torsion pendulum - Applications of torsion pendulum - Bending of beams - Experimental determination of Young's modulus: Uniform bending and non-uniform bending.	
UNIT II	**ELECTROMAGNETIC THEORY**	**9+3+3 hrs**
	Laws of electrostatics - Electrostatic field and potential of a dipole; Dielectric Polarisation, Dielectric constant, internal field - Clausius Mossotti Equation - Laws of magnetism - Ampere's Faraday's law; Lenz's law - Maxwell's equation - Plane electromagnetic waves; their transverse nature - expression for plane, circularly and elliptically polarized light - quarter and half wave plates - production and detection of plane, circularly and elliptically polarized light.	
UNIT III	**OPTICS, LASERS AND FIBRE OPTICS**	**9+3+12 hrs**
	Optics: Dispersion- Optical instrument: Spectrometer - Determination of refractive index and dispersive power of a prism- Interference of light in thin films: air wedge - Diffraction: grating. **LASER**: Introduction - Population inversion -Pumping - Laser action - Nd-YAG laser - CO_2 laser - Applications **Fibre Optics:** Principle and propagation of light in optical fibre - Numerical aperture and acceptance angle - Types of optical fibre - Fibre optic communication system (Block diagram).	

UNIT IV SEMICONDUCTOR PHYSICS 9+3+6 hrs

Semiconductors: Energy bands in solids - Energy band diagram of good conductors, insulators and semiconductors - Concept of Fermi level - Intrinsic semiconductors - Concept of holes - doping - Extrinsic semiconductors - P type and N type semiconductors - Hall effect.

Diodes and Transistors**:** P-N junction diode - Forward bias and reverse bias - Rectification action of diode - Working of full wave rectifier using P N junction diodes - PNP and NPN transistors - Three different configurations - Advantages of common emitter configuration - working of NPN transistor as an amplifier in common emitter configuration.

UNIT V QUANTUM PHYSICS 9+3+0 hrs

Introduction to quantum physics, black body radiation, Compton effect, de Broglie hypothesis, wave – particle duality, uncertainty principle, Schrodinger wave equation (Time dependent and Time independent), particle in a box, Extension to three dimension - Degeneracy.

L = 45 hrs T = 15 hrs P=30 hrs Total = 90 hrs

	LIST OF EXPERIMENTS :
1.	Torsional Pendulum - determination of moment of inertia and rigidity modulus of the gi material of the wire.
2.	Uniform Bending - Determination of the Young's Modulus of the material of the beam.
3.	Non-Uniform Bending - Determination of the Young's Modulus of the material of the beam.
4.	Meter Bridge - Determination of specific resistance of the material of the wire.
5.	Spectrometer - Determination of dispersive power of the give prism.
6.	Spectrometer - Determination of wavelength of various colours in Hg source using grating.
7.	Air wedge - Determination of thickness of a given thin wire.
8.	Laser - Determination of wavelength of given laser source and size of the given micro parti using Laser grating.
9.	Post office Box - Determination of band gap of a given semiconductor.
10.	PN Junction Diode - Determination of V-I characteristics of the given diode.

TEXT BOOKS

1. Gaur R. K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publications, 2009.
2. Avadhanulu M. N. "Engineering Physics" (Volume I and II), S. Chand & Company Ltd., New Delhi, 2010.

REFERENCES

1. Palanisamy P. K., "Engineering Physics", Scitech Publications (India) Pvt. Ltd, Chennai.
2. Arumugam M., "Engineering Physics" (Volume I and II), Anuradha Publishers, 2010.
3. Senthil Kumar G., “Engineering Physics", 2nd Enlarged Revised Edition, VRB Publishers,

Chennai, 2011.
4. Mani P., "Engineering Physics", Dhanam Publications, Chennai, 2007.
5.Samir Kumar Ghosh, "A text book of Advanced Practical Physics", New Central Agency (P) Ltd, 2008.
6.Arora C.L., "Practical Physics", S. Chand & Company Ltd., New Delhi, 2013.
Umayal Sundari AR., "Applied Physics Laboratory Manual", PMU Press, Thanjavur, 2012.

E-REFERENCES

NPTEL , Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO 12
CO1	3	2	2	2	1	-	-	-	1	-	-	1
CO2	3		1		1	-	-	-		-	-	1
CO3	3	2	2	2	1	-	-	-	1	-	-	1
CO4	3	2	2	2	1	-	-	-	1	-	-	1
CO5	3		2			-	-	-		-	-	1
Total	**15**	**6**	**9**	**6**	**4**				**3**			**5**

1 - Low, 2 – Medium, 3- High

Semester	**II**
Subject Name	**Engineering Graphics**
Subject Code	**XEG205**

L –T –P –C	C:P:A	L –T –P –H
2- 0 – 1– 3	**1.75:1:0.25**	**2- 0– 2 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Apply*** the national and international standards, ***construct*** and ***practice*** various curves	Cognitive (Apply) Psychomotor (Guided response) Affective (Responds to Phenomena)
CO2	***Interpret, construct*** **and** ***practice*** orthographic projections of points, straight lines and planes.	Cognitive (Understand) Psychomotor (Mechanism) Affective (Responds to

		Phenomena)
CO3	***Construct Sketch* and *Practice*** projection of solids in various positions and true shape of sectioned solids.	Cognitive (Apply) Psychomotor (Complex over response) Affective (Responds to phenomena)
CO4	***Interpret, Sketch* and *Practice*** the development of lateral surfaces of simple and truncated solids, intersection of solids.	Cognitive (Understand) Psychomotor (Complex over response) Affective (Responds to phenomena)
CO5	***Construct sketch* and *practice*** isometric and perspective views of simple and truncated solids.	Cognitive (Apply) Psychomotor (Complex over response) Affective (Responds to phenomena)

Objectives:

- to prepare the student to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare the student to communicate effectively
- to prepare the student to use the techniques, skills, and modern engineering tools necessary for engineering practice

COURSE CONTENT

UNIT I	**INTRODUCTION, FREE HAND SKETCHING OF ENGG OBJECTS AND CONSTRUCTION OF PLANE CURVE**	**12+6 hrs**

Importance of graphics in engineering applications – use of drafting instruments – BIS specifications and conventions as per SP 46-2003.

Pictorial representation of engineering objects – representation of three dimensional objects in two dimensional media – need for multiple views – developing visualization skills through free hand sketching of three dimensional objects.

Polygons & curves used in engineering practice – methods of construction – construction of ellipse, parabola and hyperbola by eccentricity method – cycloidal and involute curves – construction – drawing of tangents to the above curves. Practice on basic tools of CAD

UNIT II	**PROJECTION OF POINTS, LINES AND PLANE**	**12+6 hrs**

	SURFACES	
	General principles of orthographic projection – first angle projection – layout of views – projections of points, straight lines located in the first quadrant – determination of true lengths of lines and their inclinations to the planes of projection – traces – projection of polygonal surfaces and circular lamina inclined to both the planes of projection-CAD practice on points and lines	
UNIT III	**PROJECTION OF SOLIDS AND SECTIONS OF SOLIDS**	**12+6 hrs**
	Projection of simple solids like prism, pyramid, cylinder and cone when the axis is inclined to one plane of projection – change of position & auxiliary projection methods – sectioning of above solids in simple vertical positions by cutting plane inclined to one reference plane and perpendicular to the other and above solids in inclined position with cutting planes parallel to one reference plane – true shapes of sections-CAD practice on solid models	
UNIT IV	**DEVELOPMENT OF SURFACES AND INTERSECTION OF SOLIDS**	**12+6 hrs**
	Need for development of surfaces – development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones – development of lateral surfaces of the above solids with square and circular cutouts perpendicular to their axes – intersection of solids and curves of intersection –prism with cylinder, cylinder & cylinder, cone & cylinder with normal intersection of axes and with no offset-CAD practice on intersection of solids.	
UNIT V	**ISOMETRIC AND PERSPECTIVE PROJECTIONS**	**12+6 hrs**
	Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones – principles of perspective projections – projection of prisms, pyramids and cylinders by visual ray and vanishing point methods-CAD practice on isometric view	

L = 30 hrs T = 0 hrs P=60 hrs Total = 90 hrs

TEXT BOOKS

1. Bhatt,N.D, “Engineering Drawing”, Charotar Publishing House, 46th Edition-2003.
2. Natarajan,K.V, “ A Textbook of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2006 .
3. Dr. P.K. Srividhya, P. Pandiyaraj, “Engineering Graphics”, PMU Publications, Vallam, 2013

REFERENCES

1. Luzadder and Duff, “Fundamentals of Engineering Drawing” Prentice Hall of India PvtLtd, XI Edition - 2001.
2. Venugopal,K. and Prabhu Raja, V., “Engineering Graphics”, New Age International(P) Ltd., 2008.
3. Gopalakrishnan.K.R,. “Engineering Drawing I & II”, Subhas Publications, 1998.
4. Shah,M.B and Rana,B.C.,”Engineering Drawing”, Pearson Education,2005.

E-REFERENCES

1. http://periyarnet/Econtent

2. http://nptel.ac.in/courses/112103019/

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO 12	PS O1	PS O2
CO1	3	3	3	2	3	2	3	1	1	2	3	3	3	
CO2	3	3	3	1	3	1	3	1	1	1	2	3	3	
CO3	3	3	3	1	3	1	3	1	1	1	2	3	3	
CO4	3	3	3	1	3	1	3	1	1	1	2	3	3	
CO5	3	3	3	1	3	1	3	1	1	1	2	3	3	
Total	15	15	15	6	15	6	15	5	5	6	11	15	15	

1 - Low, 2 – Medium, 3- High

Semester	**III**
Subject Name	**PDE, PROBABILITY & STATISTICS**
Subject Code	**XME301**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3.5:0.25:0.25**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	**Solve** homogeneous and non homogeneous linear partial differential equations of second order by complementary function and particular integral method.	Cognitive (Apply)
CO2	**Solve** one dimensional heat equation, wave equation using separation of variables method to simple problems in Cartesian coordinates.	Cognitive (Apply)
CO3	**Find** expectation values and moments of a discrete and continuous random variables and their properties, distribution functions Define densities of normal, exponential and gamma.	Cognitive (Remember) Psychomotor (Guided Response)
CO4	**Find** statistical parameters of the Binomial, Poisson and Normal distributions and to find correlation, regression and rank correlation coefficients of two variables.	Cognitive (Remember)
CO5	**Apply** large sample test for single proportion, difference of proportions, single mean, difference of means and to test ratio of variances, Chi square.	Cognitive(Apply) Affective(Receiving)

Objective

(1) To introduce the solution methodologies for second order Partial Differential Equations with

applications in engineering

(2) To provide an overview of probability and statistics to engineers

COURSE CONTENT

UNIT I **12 hrs**

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method.

UNIT II **12 hrs**

Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

UNIT III **12 hrs**

Expectation of Discrete Random Variables, Moments, Variance of a sum, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

UNIT IV **12 hrs**

Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

UNIT V **12 hrs**

Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

L = 45 hrs T = 15 hrs P=0 hrs Total = 60 hrs

TEXT BOOKS

1.B .S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43rd Edition, 2015.

2. N.P. Bali and Manish Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, Reprint, 2010.

REFERENCES

1.P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Probability Theory”, Universal Book Stall, 2003 (Reprint).

2. S. Ross, “A First Course in Probability”, 6th Ed., Pearson Education India, 2002.

3. Erwin Kreyszig, “Advanced Engineering Mathematics”, 9th Edition, John Wiley & Sons, 2006.

E-REFERENCES

Nptel

Probability and Statistics by Prof.Someshkumar, Department of Mathematics, IIT Kharagpur. (http://nptel.ac.in/noc/noc_courselist.php)

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	1						1	1		1
CO2	3	2	1						1	1		1
CO3	3	2	1	1					1	1		1
CO4	3	2	1	1	1	1			1	1	1	1
CO5	3	2	1	1	1	1	1		1	1	1	1
Total	15	10	5	3	2	2	1		5	5	2	5

1 - Low, 2 – Medium, 3- High

Semester	**III**
Subject Name	**THERMODYNAMICS**
Subject Code	**XME302**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3.5:0.25:0.25**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	After completing this course, the students will be able to ***apply*** energy balance to systems and control volumes, in situations involving heat and work interactions	Cognitive
CO2	Students can ***Study*** the changes in thermodynamic properties of substances	Cognitive
CO3	The students will be able to ***study*** the performance of energy conversion devices	Cognitive
CO4	The students will be able to ***differentiate*** between high grade and low grade energies.	Cognitive
CO5	Student can ***apply*** the energy balance to systems operating at different cycles.	Cognitive

The objective of this course

- To learn about work and heat interactions, and balance of energy between system and its surroundings
- To learn about application of I law to various energy conversion devices
- To evaluate the changes in properties of substances in various processes
- To understand the difference between high grade and low grade energies and II law

limitations on energy conversion

COURSE CONTENT

UNIT I	**BASIC CONCEPTS**	**5 hrs**

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

UNIT II	**LAWS OF THERMODYNAMICS**	**5 hrs**

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy

UNIT III	**PROPERTIES OF SUBSTANCES AND STEAM TABLES**	**8 hrs**

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

UNIT IV	**FLOW PROCESS AND THERMO DYNAMIC RELATIONS**	**10 hrs**

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

UNIT V	**ENTROPY AND CYCLES**	**12 hrs**

Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis

Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.

L = 40 hrs T = 12 hrs P=0 hrs Total = 52 hrs

TEXT BOOKS / REFERENCES

1.Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	P O 12	PSO 1	PSO 2
CO1	2	-	1	-	3	-	2	2	2	-	-	2		3
CO2	3	-	-	2	3	-	1	-	1	-	-	3		3
CO3	1	-	1	3	1	-	1	2	-	2	-	1		3
CO4	2	-	-	1	1	-	2	1	2	2	-	1		3
CO5	-	-	-	1	1	-	-	-	1	1	-	2		3
Tota l	8	-	2	7	9	-	6	5	6	5	-	9		15

1 - Low, 2 – Medium, 3- High

Semester	**III**
Subject Name	**STRENGTH OF MATERIALS**
Subject Code	**XME303**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3.5:0.25:0.25**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	After completing this course, the students should be able to recognize various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components	Cognitive
CO2	The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading	Cognitive

CO3	The students will be able to understand inertia and different types of springs and evaluate the different types of inertia and deflection of different types of beams with different loading conditions.	Cognitive
CO4	The students will be able to understand torsion on shaft and springs and evaluate deflection, torsional stresses on shaft, helical spring and leaf spring	Cognitive
CO5	After completing this course, The students will be able to understand and compute stresses in hollow cylindrical and spherical objects.	Cognitive

Objectives

- To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
- To calculate the elastic deformation occurring in various simple geometries for different types of loading

COURSE CONTENT

UNIT I	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**8 hrs**
	Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle	
UNIT II	**BEAMS - LOADS AND STRESSES**	**8 hrs**
	Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads	
UNIT III	**DEFLECTION OF BEAMS**	**8 hrs**
	Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems	
UNIT IV	**TORSION AND SHAFTS**	**8 hrs**
	Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs	
UNIT V	**ANALYSIS OF STRESSES IN TWO DIMENSIONS**	**8 hrs**
	Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure	

L = 40 hrs T = 12 hrs P=0 hrs Total = 52 hrs

TEXT BOOKS / REFERENCES

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

2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO 2
CO1	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO2	3	3	2	3	3	1	2	1	2	1	3	3	2	
CO3	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO4	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO5	3	3	2	3	3	1	2	1	2	1	3	3	2	
Total	15	15	10	15	15	5	10	5	10	5	12	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**III**
Subject Name	**ENGINEERING MECHANICS**
Subject Code	**XEM304**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**3.5:0.25:0.25**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Explain*** the principles forces, laws and their applications.	Cognitive-Understanding, Apply
CO2	***Classification*** of friction, and ***apply*** the forces in Trusses and beams.	Cognitive-Understanding, Apply
CO3	***Explain*** and ***Apply*** moment of Inertia and Virtual work	Cognitive-Understanding, Apply
CO4	***Outline*** and ***Examine*** Dynamics	Cognitive-Understanding, Apply
CO5	***Explain*** free and forced vibration	Cognitive-Remember, Understanding

Objectives

- The objective of this Course is to provide an introductory treatment of Engineering Mechanics to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters.
- A working knowledge of statics with emphasis on force equilibrium and free body diagrams.
- Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions.

COURSE CONTENT

UNIT I	**INTRODUCTION TO ENGINEERING MECHANICS**	**9+6 hrs**
	Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy	
UNIT II	**FRICTION AND BASIC STRUCTURAL ANALYSIS**	**9+6 hrs**
	Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines	
UNIT III	**CENTROID , CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD**	**9+6 hrs**
	Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook. Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.	
UNIT IV	**REVIEW OF PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS OF RIGID BODIES**	**9+6 hrs**
	Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of	

connected bodies; Kinetics of rigid body rotation.

UNIT V MECHANICAL VIBRATIONS 9+6 hrs

Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums

L = 45 hrs T = 30 hrs P=0 hrs Total = 75 hrs

TEXT BOOKS / REFERENCES

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Upon successful completion of the course, student will have:

- Ability to apply mathematics, science, and engineering
- Ability to design and conduct experiments, as well as to analyze and interpret data
- Ability to identify, formulate, and solve engineering problems
- Ability to apply modern engineering tools, techniques and resources to solve complex mechanical engineering activities with an understanding of the limitations.
- Ability to comprehend the thermodynamics and their corresponding processes that influence the behavior and response of structural components
- Ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) and thermodynamics to model, analyze, design, and realize physical systems, components, or processes

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	P O 12	PSO 1	PSO 2
CO1	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO2	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO3	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO4	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO5	2	2	2	1	3	1	1	3	3	3	1	3	2	
Tota l	15	10	6	5	15	5	5	11	15	11	5	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**III**	
Subject Name	**ENTREPRENEURSHIP DEVELOPMENT**	
Subject Code	**XUM305**	
L –T –P –C **3- 0 – 0– 3**	**C:P:A** **2.7:0:0.3**	**L –T –P –H** **3- 0– 0 – 3**

Course Outcome		**Domain/Level** **C or P or A**
CO1	***Recognise*** and ***describe*** the personal traits of an entrepreneur.	C (Understand) A(Receiving)
CO2	***Determine*** the new venture ideas and ***analyse*** the feasibility report.	C(Understand, Analyze)
CO3	***Develop*** the business plan and ***analyse*** the plan as an individual or in team.	C (Analyze) A(Receiving)
CO4	***Describe*** various parameters to be taken into consideration for launching and managing small business.	C (Understand)
CO5	***Explain*** the technological management and Intellectual Property Rights	C (Understand)

COURSE CONTENT

UNIT I	**ENTREPRENEURIAL TRAITS AND FUNCTIONS**	**9 hrs**
	Definition of Entrepreneurship; competencies and traits of an entrepreneur; factors affecting Entrepreneurship Development; Role of Family and Society ; Achievement	

	Motivation; Entrepreneurship as a career and national development;	
UNIT II	**NEW PRODUCT DEVELOPMENT AND VENTURE CREATION**	**9hrs**
	Ideation to Concept development; Sources and Criteria for Selection of Product; market assessment ; Feasibility Report ;Project Profile; processes involved in starting a new venture; legal formalities; Ownership; Case Study.	
UNIT III	**ENTREPRENEURIAL FINANCE**	**9 hrs**
	Financial forecasting for a new venture; Finance mobilization; Business plan preparation; Sources of Financing, Angel Investors and Venture Capital; Government support in startup promotion.	
UNIT IV	**LAUNCHING OF SMALL BUSINESS AND ITS MANGEMENT**	**9hrs**
	Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units.	
UNIT V	**TECHNOLOGY MANAGEMENT, IPR PORTFOLIO FOR NEW PRODUCT VENTURE**	**9hrs**
	Technology management; Impact of technology on society and business; Role of Government in supporting Technology Development and IPR protection; Entrepreneurship Development Training and Other Support Services.	
L = 45 hrs T = 0 hrs P=0hrs Total = 45hrs		

TEXT BOOKS

1. Hisrich, 2016, *Entrepreneurship*, Tata McGraw Hill, New Delhi.

2. S.S.Khanka, 2013, *Entrepreneurial Development*, S.Chand and Company Limited, New Delhi.

REFERENCES

1. Mathew Manimala, 2005, *Entrepreneurship Theory at the Crossroads, Paradigms & Praxis*, Biztrantra ,2nd Edition.

2. Prasanna Chandra, 2009, *Projects – Planning, Analysis, Selection, Implementation and Reviews*, Tata McGraw-Hill.

3. P.Saravanavel, 1997, *Entrepreneurial Development*, Ess Pee kay Publishing House, Chennai.

4. Arya Kumar,2012, *Entrepreneurship: Creating and Leading an Entrepreneurial Organisation*, Pearson Education India.

5. Donald F Kuratko, T.V Rao, 2012, *Entrepreneurship: A South Asian perspective*, Cengage Learning India.

6. Dinesh Awasthi, Raman Jaggi, V.Padmanand, Suggested Reading / Reference Material for Entrepreneurship Development Programmes (EDP/WEDP/TEDP), EDI Publication, Entrepreneurship Development Institute of India, Ahmedabad. Available from:

http://www.ediindia.org/doc/EDP-TEDP.pdf

E-REFERENCES

1. Jeff Hawkins, " Characteristics of a successful entrepreneur", ALISON Online entrepreneurship courses, "https://alison.com/learn/entrepreneurial-skills
2. Jeff Cornwall, "Entrepreneurship -- From Idea to Launch", Udemy online Education, https://www.udemy.com/entrepreneurship-from-idea-to-launch/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	1	0	3	1	0	3	1	2	2	1	1
CO2	1	2	3	1	0	3	1	3	3	1	2	2	1	1
CO3	1	2	3	1	0	3	1	0	3	1	2	2	1	1
CO4	1	2	2	1	0	3	1	1	3	3	3	3	1	1
CO5	1	3	3	1	0	3	1	3	3	3	3	3	1	1
	5	10	14	5	0	15	5	7	15	9	12	12	5	5

1 - Low , 2 – Medium , 3- High

Semester	**III**	
Subject Name	**MANUFACTURING PROCESSES**	
Subject Code	**XME306**	
L –T –P –C **3- 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3- 0– 0 – 3**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Summarise the metal casting and metal forming process. Identify the defects in the metal casting process.	C (Understand)
CO2	Relate the various cutting force components for the formation of chip. Identify the tool wear, tool life, cutting tool materials, cutting fluids.	C(Apply)
CO3	Compare various additive manufacturing and joining process	C (Understand)
CO4	Explain electrical energy and chemical based unconventional	C (Understand)

	machining process	
CO5	Explain mechancial and thermal energy based unconventional machining process	C (Understand)

Objectives:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods

COURSE CONTENT

UNIT I	**CONVENTIONAL MANUFACTURING PROCESSES**	**9 hrs**
	Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.	
UNIT II	**METAL CUTTING**	**9hrs**
	Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining	
UNIT III	**ADDITIVE MANUFACTURING AND JOINING PROCESS**	**9 hrs**
	Rapid prototyping and rapid tooling Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.	
UNIT IV	**UNCONVENTIONAL MACHINING PROCESSES – ELECTRICAL ENERGY AND CHEMICAL BASED PROCESS**	**9hrs**
	Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish.	
UNIT V	**UNCONVENTIONAL MACHINING PROCESSES – MECHANCIAL AND THERMAL ENERGY BASED PROCESS**	**9hrs**
	Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic, Machining, principles and process parameters	
L = 45 hrs T = 0 hrs P=0hrs Total = 45hrs		

TEXT BOOKS

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India,2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

REFERENCES

1. Paul Degarma E, Black J.T. and Ronald A. Kosher, Elighth Edition, Materials and
2. Processes, in Manufacturing Prentice – Hall of India, 2003.
3. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd., 2004.
4. P.N. Rao, Manufacturing Technology- Foundry, Forming and Welding, TMH-2003; 2nd Edition, 2003
5. Roy. A. Lindberg, Processes and Materials of Manufacture, PHI / Pearson Education, 2006.
6. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.
7. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998
8. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	2	-	-	2	-	1	2	3	3	
CO2	3	3	3	1	2	-	-	2	-	1	2	3	3	
CO3	3	3	3	1	2	-	-	2	-	1	2	3	3	
CO4	3	3	3	-	2	-	-	2	-	1	2	3	3	
CO5	3	3	3	-	2	-	-	2	-	1	2	3	3	
	15	15	15	2	10	-	-	10	-	5	10	15	15	

1 - Low, 2 – Medium, 3- High

Semester	**III**	
Subject Name	**Inplant Training – I (15 days)**	
Subject Code	**XME307**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 0	**0:2:0**	**0- 0– 2– 0**
Course Outcome		**Domain/Level C or P or A**

Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Semester	**IV**	
Subject Name	**APPLIED THERMODYNAMICS**	
Subject Code	**XME401**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1– 0– 4	**3.5:0.25:0.25**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	Understanding of basic fuel types and Calculation of air fuel mixtures or combustion	C (Understand)
CO2	After completing this course, the students will get a good understanding of various practical power cycles and heat pump cycles.	C(Understand, Analyze)
CO3	Understanding of basic principles of psychrometry and solving the problems of psychrometric chart.	C (Analyze)
CO4	They will be able to understand phenomena occurring in high speed compressible flow	C (Understand)
CO5	They will be able to analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors.	C (Understand)

Objectives

(1) To learn about of I law for reacting systems and heating value of fuels

(2) To learn about gas and vapor cycles and their first law and second law efficiencies

(3) To understand about the properties of dry and wet air and the principles of psychrometry

(4) To learn about gas dynamics of air flow and steam through nozzles

(5) To learn the about reciprocating compressors with and without intercooling

(6) To analyze the performance of steam turbines

COURSE CONTENT

UNIT I	**Fuels and Stoichiometry**	**8 hrs**
	Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy	
UNIT II	**Power cycles**	**12 hrs**
	Vapor power cycles Rankine cycle with superheat, reheat and regeneration, enregy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties	
UNIT III	**Psychyrometry**	**4 hrs**
	Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.	
UNIT IV	**Compressible flow and Shocks**	**8 hrs**
	Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation- compressible flow in diffusers, efficiency of nozzle and diffuser	
UNIT V	**Compressors and Steam turbines**	**8 hrs**
	Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors and Analysis of steam turbines, velocity and pressure compounding of steam turbines	
L = 40 hrs T = 12 hrs P=0hrs Total = 52hrs		

TEXT BOOKS / REFERENCES

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	0	0	0	1	3	0	3	3		3
CO2	3	3	1	0	2	0	0	2	3	0	3	3		3
CO3	3	3	1	1	1	0	0	2	3	0	3	3		3
CO4	3	3	1	0	0	0	0	0	3	0	3	3		3
CO5	1	2	1	0	0	0	0	3	3	0	3	3		3
	13	13	5	3	3	0	0	8	15	0	15	15		15

1 - Low, 2 – Medium, 3- High

Semester	**IV**
Course Name	**SOLID MECHANICS**
Course Code	**XME402**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 1 – 0– 4	**3.5:0.25:0.25**	**3–1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand and apply the concepts of 3-dimensional state of strain and stress under different types of loading	C (U), C (App)
CO2	Understand and apply constitutive relations for simple geometries	C (U), C (App)
CO3	Apply the deformation concepts for plane stress and plane strain problems	C (App)
CO4	Apply the deformation concepts for complex cases	C (App)
CO5	Understand and apply energy and potential methods.	C (U), C (App)

Objectives:

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

COURSE CONTENT

UNIT I	**STRAIN AND STRESS**	**9+6 = 15 Hours**

Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and

symmetry equations, principal stresses and directions

UNIT II CONSTITUTIVE EQUATIONS 9+6 = 15 Hours

Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.

UNIT III PLANE STRESS AND PLANE STRAIN 9+6 = 15 Hours

Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.

UNIT IV APPLICATION TO COMPLEX CASES 9+6 = 15 Hours

Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems.

UNIT V ENERGY METHODS 9+6 = 15 Hours

Solutions using potentials. Energy methods. Introduction to plasticity.

L = 45 Hours Tutorial = 15 Hours Total = 60 Hours

TEXT BOOKS

1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

REFERENCES

1. S. M. A. Kazimi, Solid Mechanics, First Edition, Tata McGraw Hill Publications, 2001.

E-REFERENCES

1. https://nptel.ac.in/courses/112107147
2. https://nptel.ac.in/syllabus/105101003

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	1	-	-	-	1	-	-	-	2	
CO2	3	2	-	2	1	-	-	-	1	-	1	1	2	
CO3	3	1	-	1	1	-	-	1	1	-	1	1	2	
CO4	3	2	-	2	1	-	-	-	1	-	-	-	2	
CO5	3	3	3	3	2	-	-	2	1	-	3	3	2	
	15	10	3	10	6			3	5		5	5	10	

1 - Low, 2 – Medium, 3- High

Semester	**IV**
Course Name	**HUMAN ETHICS, VALUES, RIGHTS AND GENDER EQUALITY**
Course Code	**XUM403**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 0	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Relate*** and ***Interpret*** the human ethics and human relationships	C(Remember, Understand)
CO2	***Explain*** and ***Apply*** gender issues, equality and violence against women	C(Understand, Apply)
CO3	***Classify*** and ***Develop*** the identify of women issues and challenges.	C (Analyze) A (Receive)
CO4	***Classify*** and ***Dissect*** human rights and report on violations.	C(Understand. Analyze)
CO5	***List*** and **respond** to family values, universal brotherhood, fight against corruption by common man and good governance.	C (Remember) A(Respond)

COURSE CONTENT

UNIT I	**HUMAN ETHICS AND VALUES**	**7 Hours**

Human Ethics and values - Understanding of oneself and others- motives and needs- Social service, Social Justice, Dignity and worth, Harmony in human relationship: Family and Society, Integrity and Competence, Caring and Sharing, Honesty and Courage, WHO's holistic development - Valuing Time, Co-operation, Commitment, Sympathy and Empathy, Self respect, Self-Confidence, character building and Personality.

UNIT II	**GENDER EQUALITY**	**9 Hours**

Gender Equality - Gender Vs Sex, Concepts, definition, Gender equity, equality, and empowerment. Status of Women in India Social, Economical, Education, Health, Employment, HDI, GDI, GEM. Contributions of Dr.B.R. Ambethkar, Thanthai Periyar and Phule to Women Empowerment.

UNIT III	**WOMEN ISSUES AND CHALLENGES**	**9 Hours**

Women Issues and Challenges- Female Infanticide, Female feticide, Violence against women, Domestic violence, Sexual Harassment, Trafficking, Access to education, Marriage. Remedial Measures – Acts related to women: Political Right, Property Rights, and Rights to Education, Medical Termination of Pregnancy Act, and Dowry Prohibition Act.

UNIT IV	**HUMAN RIGHTS**	**9 Hours**

Human Rights Movement in India – The preamble to the Constitution of India, Human Rights and Duties, Universal Declaration of Human Rights (UDHR), Civil, Political, Economical, Social and Cultural Rights, Rights against torture, Discrimination and forced Labour, Rights and protection of children and elderly. National Human Rights Commission and other statutory Commissions, Creation of Human Rights Literacy and Awareness. - Intellectual Property Rights (IPR). National Policy on occupational safety, occupational health and working environment.

UNIT V GOOD GOVERNANCE AND ADDRESSING SOCIAL ISSUES **11 Hours**

Good Governance - Democracy, People's Participation, Transparency in governance and audit, Corruption, Impact of corruption on society, whom to make corruption complaints, fight against corruption and related issues, Fairness in criminal justice administration, Government system of Redressal. Creation of People friendly environment and universal brotherhood.

L = 15 Hours Self study – 30 Hours Tutorial = 0 Hours Total = 45 Hours

REFERENCES

1. Aftab A, (Ed.), Human Rights in India: Issues and Challenges, (New Delhi: Raj Publications, 2012).
2. Bajwa, G.S. and Bajwa, D.K. Human Rights in India: Implementation and Violations (New Delhi: D.K. Publications, 1996).
3. Chatrath, K. J. S., (ed.), Education for Human Rights and Democracy (Shimala: Indian Institute of Advanced Studies, 1998).
4. Jagadeesan. P. Marriage and Social legislations in Tamil Nadu, Chennai: Elachiapen Publications, 1990).
5. Kaushal, Rachna, Women and Human Rights in India (New Delhi: Kaveri Books, 2000)
6. Mani. V. S., Human Rights in India: An Overview (New Delhi: Institute for the World Congress on Human Rights, 1998).
7. Singh, B. P. Sehgal, (ed) Human Rights in India: Problems and Perspectives (New Delhi: Deep and Deep, 1999).
8. Veeramani, K. (ed) Periyar on Women Right, (Chennai: Emerald Publishers, 1996)
9. Veeramani, K. (ed) Periyar Feminism, (Periyar Maniammai University, Vallam, Thanjavur: 2010).
10. Central Vigilance Commission (Gov. of India) website: http://cvc.nic.in/welcome.html.
11. Weblink of Transparency International: https://www.transparency.org/

Weblink Status report: https://www.hrw.org/world-report/2015/country-chapters/india

Table 1: Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1								2						
CO2								3	1					
CO3								2						
CO4								3		2				
CO5								3	2	2		2		

Total		2						13	3	4		2		
Scaled Value		1						3	1	1		1		

1 – 5 → 1, 6-10 → 2, 11 – 15→ 3
0 – No relation, 1 – Low relation, 2 – Medium relation, 3 – High relation

Semester	**IV**
Course Name	**FLUID MECHANICS & FLUID MACHINES**
Course Code	**XME404**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 1 – 0– 4	**3.5:0.25:0.25**	**3–1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	**Recalling** of fluids properties and **understanding** the equations related to fluid flow. Ability to **solve** problems related to momentum equation and Bernoulli's equation	**Cognitive-** Remembering, understanding and apply
CO2	**Understanding** the concept of incompressible fluid flow fluid flow through channels and ducts. **Discuss** the concept of boundary layer and ability **apply** Darcy Weisbach equation in different condition	**Cognitive-** Understanding and apply
CO3	**Understanding** the need and methods of dimensional analysis and ability to **derive** equations using dimensional analysis	**Cognitive-** Understanding and apply
CO4	**Explain** the working of different types of pumps and ability to **analyze** its performance	**Cognitive-** Understanding analyze and apply
CO5	**Explain** the working of different types of turbines and ability to **analyze** its performance	**Cognitive-** Understanding analyze and apply

Objectives

- To learn about the application of mass and momentum conservation laws for fluid flows
- To understand the importance of dimensional analysis
- To obtain the velocity and pressure variations in various types of simple flows
- To analyze the flow in water pumps and turbines.

COURSE CONTENT

UNIT I	**BASIC CONCEPTS AND PROPERTIES OF FLUIDS**	**9 Hours**

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface

tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications

UNIT II IN COMPRESSIBLE FLUID FLOW 9 Hours

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram

UNIT III DIMENSIONAL ANALYSIS 6 Hours

Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis

UNIT IV HYDRAULIC PUMPS 8 Hours

Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle

UNIT V HYDRAULIC TURBINES 8 Hours

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines

L = 40 Hours Tutorial = 12 Hours Total = 52 Hours

TEXT BOOKS / REFERENCE BOOKS

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 2003.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.
3. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 2008.
4. Som, S.K., and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2004.
5. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 2005.
6. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, 2008.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	1	1	3	1	1	1	1	1	1	1		2
CO2	3	3	2	1	3	1	1	2	2	2	1	2		2

CO3	3	3	0	1	3	1	0	2	1	1	0	1		2
CO4	3	3	1	2	3	1	1	2	2	2	1	2		2
CO5	3	3	2	2	3	1	1	2	2	2	1	2		2
Tot	15	15	6	7	15	5	4	9	10	10	4	8		10

1 - Low, 2 – Medium, 3- High

Semester	**IV**
Course Name	**MATERIALS ENGINEERING**
Course Code	**XME405**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Recall*** the Basic Properties of Engineering Materials.	Cognitive
CO2	***Classify*** static failure theories.	Cognitive
CO3	***Classify*** the concepts of iron and steel.	Cognitive
CO4	***Analyze*** the heat treatment process and its applications.	Cognitive
CO5	***Analyze*** the properties of alloys.	Cognitive

Objectives

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.

2. To provide a detailed interpretation of equilibrium phase diagrams

3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

COURSE CONTENT

UNIT I	**PROPERTIES OF METALLIC MATERIALS**	**9 Hours**

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids:Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slipsystems, critically resolved shear stress.Mechanical Property measurement: Tensile, compression and torsion tests; Young'smodulus, relations between true and engineering stress-strain curves, generalized Hooke'slaw, yielding and yield strength, ductility, resilience, toughness and elastic recovery;Hardness: Rockwell, Brinell and Vickers and their relation to strength.

UNIT II	**STATIC FAILURE THEORIES**	**9 Hours**

Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture

mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT).

UNIT III ALLOYS AND PHASE DIAGRAMS 9 Hours

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

UNIT IV HEAT TREATMENT OF MATERIALS 9 Hours

Heat treatment of Steel: Annealing, tempering, normalizing and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

UNIT V MODERN ENGINEERING MATERIALS 9 Hours

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys.

L = 45 Hours Tutorial = 0 Hours Total = 45 Hours

TEXT BOOKS

1. W. D. Callister, 2006, “Materials Science and Engineering-An Introduction”, 6th Edition,Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, “Material Science and Engineering’, Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, “Engineering Materials and Metallurgy”, Pearson, 2011.

REFERENCE BOOKS

1. Koch, C. C. Nanostructured materials: processing and applications: William Andrew Pub.
2.James F Shackelford, S “Introduction to materials Science for Engineers”, 6 th Macmillan Publishing Company, New York, 2004
3.William D CallisterJr, “Materials Science and Engineering – An Introduction”, John Wiley and Sons Inc., 6 th edition, New York, 2003
4.Jayakumar S, “Materials Science”, RK Publishers, Coimbatore, 2004
5. Bolton, W., Engineering materials technology: Butterworth-Heinemann.

E RESOURCES

1.NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering &Metallurgy and Material Science categories
2.http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	3	3	1	1	-	2	3	3	1	3	2	1
CO2	3	3	1	1	1	-	-	1	1	2	3	2	2	1
CO3	3	2	1	1	1	-	-	1	2	3	1	3	2	1
CO4	2	3	1	3	1	-	-	1	1	2	3	2	2	1
CO5	3	2	3	3	1	1	-	1	3	3	2	1	2	1
Tot	13	12	9	11	5	2		6	10	13	10	11	10	5

1 - Low, 2 – Medium, 3- High

Semester	**IV**
Course Name	**INSTRUMENTATION & CONTROL**
Course Code	**XME406**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 1 – 0– 4	**3.5:0.25:0.25**	**3–1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Understand*** the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices.	C (Understand)
CO2	***Understand*** the instrumentation system and elements.	C (Understand)
CO3	***Design*** various Controllers	C (Create)
CO4	***Understand*** the instrumentation system models and functions.	C (Understand)
CO5	***Create*** a project using Instrumentation systems.	C (Create)

Objectives:

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

COURSE CONTENT

UNIT I	**Measurement systems and Characteristics**	**9 Hours**
	Measurement systems and performance – accuracy, range, resolution, error sources.	
UNIT II	**Instrumentation systems and elements**	**9 Hours**
	Instrumentation system elements – sensors for common engineering measurements; Signal processing and conditioning; correction elements- actuators: pneumatic, hydraulic, electric.	

UNIT III	Controllers	8 Hours

Control systems – basic elements, open/closed loop, design of block diagram; control method
P, PI, PID, when to choose what, tuning of controllers.

UNIT IV	Models	8 Hours

System models, transfer function and system response, frequency response; Nyquist diagrams and their use.

UNIT V	Project	6 Hours

Practical group based project utilizing above concepts.

L = 40 Hours **Tutorial = 12 Hours** **Total = 52 Hours**

TEXT BOOKS / REFERENCE BOOKS

1.Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 200
2.Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6^{th} Edition) 6th Edition, Pearson Education India, 2007
3.Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York, 1999.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1													1	1
CO2													1	1
CO3													1	1
CO4													1	1
CO5													1	1
Tot													5	5

1 - Low, 2 – Medium, 3- High

Semester	**V**
Course Name	**Operations Research**
Course Code	**XME501**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 1 – 0– 4	**3.5:0.25:0.25**	**3–1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Explain*** the basic concepts of optimization and To F***ormulate*** and Solve linear programming problems.	C(Understand, Apply)
CO2	***Apply*** the concepts of transportation problem, assignment problem and travelling salesman problem Participate in the class discussion in the	C(Apply) A(Respond to

	transportation model.	phenomena)
CO3	***Explain*** and demonstrate the basic concepts of PERT- CPM and their applications in product planning control.	C(Understand)
CO4	***Solve*** the Minimal Spanning Tree Problem, Shortest Route Problem, Maximal Flow Problem and Minimal Cost Capacitated Flow Problem**.** Reproduce the Network model.	C(Apply) P(Guided Response)
CO5	***Apply*** the concepts of Game theory to Find the solution and saddle point.	C(Apply, Remember)

COURSE CONTENT

UNIT I	**LINEAR MODELS**	**12 Hours**
	Basics of OR, Linear programming problems (L.P.P), Mathematical Formulation of L.P.P, Graphical method, Simplex algorithm, Duality.	
UNIT II	**TRANSPORTATION MODELS**	**12 Hours**
	Transportation problem, Assignment problem, Travelling Salesman problem.	
UNIT III	**PROJECT SCHEDULING BY PERT-CPM**	**12 Hours**
	PERT-CPM, product planning control with PERT-CPM.	
UNIT IV	**NETWORK MODELS**	**12 Hours**
	Network definition, Minimal Spanning Tree Problem, Shortest Route Problem, Maximal Flow Problem, Minimal Cost Capacitated Flow Problem.	
UNIT V	**GAME THEORY**	**12 Hours**
	Introduction - competitive game - finite and infinite game - two person zero sum game - rectangular game - solution of game- saddle point, solution of a rectangular game with saddle point.	

L = 45 Hours **Tutorial = 15 Hours** **Total = 60 Hours**

TEXT BOOKS

1. Kantiswaroop,Gupta P.K and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi, (2008).(Unit I,II,III & V)
2. R.Paneerselvam, Operations Research,PHI Learning Private Limited,NewDelhi,(2010)(Unit IV)

REFERENCE BOOKS

1.Hadley G, Linear Programming, Narosa publishing House, (1995).

2. Hadley G, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass, (1973).

3. Gupta R. K. “Linear Programming”,Krishna Prakashan Media(P) Ltd. ,(2009).

E – REFERENCES

1. www.nptel.ac.in
2. Fundamentals of Operations Research, Advanced Operation Research Prof.G.Srinivasan, Department of Management Studies, Indian Institute of Technology, Madras.

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1			1		1		1	
CO2	3	1		1			1		1			
CO3	3	1		1			1		1			
CO4	3	1		1			1		1		1	
CO5	3	1		1			1		1			
Tot	15	5	0	5	0	0	5	0	5	0	2	0

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**Heat Transfer**
Subject Code	**XME502**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 - 1 – 0– 4	**3.5:0.25:0.25**	**3- 1– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand the basic modes of heat transfer and Compute temperature distribution in steady-state and unsteady-state heat conduction.	C (Rem)
CO2	Interpret and analyse forced and free convection heat transfer.	C (Rem)
CO3	Understand the principles of radiation heat transfer and basics of mass transfer.	C (Rem)
CO4	Design heat exchangers using LMTD and NTU methods.	C (Understand)
CO5	Understand the basic concepts of mass transfer	C (understand)

Objectives:

(1) The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.

(2) Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.

(3) The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

COURSE CONTENT

UNIT I	**CONDUCTION**	**10+5 hrs**

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady onedimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry,concept of conduction and film resistances, critical insulation

thickness, lumped system approximation and Biot number, heat transfer through pin fins-Two dimensional conductionsolutions for both steady and unsteady heat transfer-approximate solution to unsteady conductionheat transfer by the use of Heissler charts.

UNIT II CONVECTION 8+5 hrs

Heat convection,basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heattransfer-Correlations for forced and free convection- Approximate solutions to laminar boundarylayer equations (momentum and energy) for both internal and external flow- Estimating heat transferrates in laminar and turbulent flow situations using appropriate correlations for free and forcedconvection.

UNIT III RADIATION 8+5 hrs

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law,black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiativeproperties, view factors and the radiosity method.

UNIT IV HEAT EXCHANGERS 9+5 hrs

Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods .Boiling and Condensation heat transfer, Pool boiling curve.

UNIT V MASS TRANSFER 5+4 hrs

Introduction mass transfer, Similarity between heat and mass transfer

L = 40 hrs T = 12 hrs P=0hrs Total = 52 hrs

TEXT BOOKS

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	1	-	-	1		2
CO2	3	2	-	2	1	1		-	-	-	-	1		2
CO3	2	3	3	2	1	1	1	-	1	-	-	1		2
CO4	2	3	3	2	1	1	1	-	1	-	-	1		2
CO5	3	2	2	1	1	1	1	-	-	-	-	1		2

Total	13	12	14	9	5	4	3		3			5		10

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**Automobile Engineering**
Subject Code	**XME503**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 - 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define and identifies*** the vehicle construction, types and specification of engines.	C(Knowledge) P(Perception)
CO2	***Differentiate and calibrates*** Ignition, Fuel Supply and Emission Control System.	C(Comprehension) P(Guided response)
CO3	***Categories and illustrate*** the various types of clutches and gear boxes.	C(Synthesis) P(Mechanism)
CO4	***Characterize and determine*** *the suspension, steering geometry and wheel specification.*	C(Knowledge) P(Perception)
CO5	***Assembles and Summarize the*** *Electrical systems and Dash board instrumentations.*	C(Evaluation) P(Guided response)

COURSE CONTENT

UNIT I	**Introduction to Vehicle structure**	**9 hrs**
	Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines-components, function and materials, variable valve timing (VVT).	
UNIT II	**Ignition, Fuel Supply and Emission Control System**	**9hrs**
	Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).	
UNIT III	**Transmission System**	**9 hrs**
	Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.	
UNIT IV	**Steering, Suspension and Braking System**	**9 hrs**

Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

UNIT V **Advances in Automobile Engineering** **9 hrs**

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.
3. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
4. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO2	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO3	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO4	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO5	3	3	2	3	3	1	3	1	1	2	2	3	2	
Total	15	15	10	15	15	5	15	5	5	10	10	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**CAD / CAM**
Subject Code	**XME504**

L –T –P –C **C:P:A** **L –T –P –H**

3 - 0 – 0– 3	3:0:0	3- 0– 0 – 3

Course Outcome		Domain/Level C or P or A
CO1	***Define*** Design Process, CAD, CAM and ***explain*** various stages of design and different types of design process *explain* the DOM concept CAM along with benefits of CAD	C(Remember, Understand)
CO2	***Classify*** and ***explain*** different graphical primitives and transformations systems along with complex geometry generation techniques. ***Classify*** and ***outline*** the various Data structure and management systems.	C(Remember, Understand)
CO3	***Define*** modeling and ***Classify*** different types of geometric models also ***outline*** different features of solid modeling packages	C(Remember, Understand)
CO4	***Explain*** and *contrast* NC CNC DNC also ***illustrate*** various tools ,devices and mechanisms used inside NC,CNC and DNC	C(Understand)
CO5	***List*** important NC Codes and ***create*** CNC code for simple CNC operations like turning and facing.	C(Remember, Create)

COURSE CONTENT

UNIT I	DESIGN PROCESS	9 hrs

The design process - Morphology of design - Product cycle - Sequential and concurrent engineering - Role of computers - Computer Aided Engineering - Computer Aided Design - Design for Manufacturability – Computer Aided Manufacturing - Benefits of CAD.

UNIT II	INTERACTIVE COMPUTER GRAPHICS AND DATA STRUCTURES	9hrs

Creation of Graphic Primitives - Graphical input techniques - Display transformation in 2-D and 3-D – Viewing transformation - Clipping - hidden line elimination - Mathematical formulation for graphics - Curve generation techniques.

Model storages and Data structure - Information system. Engineering Data Management System. Hierarchical data structure. Network data structure - Relational data structure. Data storage, search and retrieval methods. Recent trends in Data Structures.

UNIT III	SOLID MODELING	9 hrs

Geometric Modeling - Wireframe, Surface and Solid models - CSG and B-REP Techniques - Features of Solid Modeling Packages - Parametric and features - Interfaces to drafting, Design Analysis.

UNIT IV	CONSTRUCTIONAL FEATURES OF CNC MACHINES	9 hrs

Numerical Control (DNC Systems). Design considerations of CNC machines for improving machining accuracy-Structural members-Slideways - Sides linear bearings -

Ball screws - Spindle drives and feed drives - work holding devices and tool holding devices -Automatic Tool changers. Feedback devices - Principles of Operation-Machining Centres - Tooling for CNC machines.

UNIT V PART PROGRAMMING FOR CNC MACHINES 9 hrs

Numerical control codes - Standards - Manual Programming - Canned cycles and subroutines – Computer Assisted Programming, CAD / CAM approach to NC part programming - APT language, machining from 3D models. Validation of Programs.

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Ibrahim Zeid, " CAD - CAM Theory and Practice ", Tata McGraw-Hill Publishing Co. Ltd., 1998.
2. Sadhu Singh, " Computer Aided Design and Manufacturing ", Khanna Publishers, New Delhi, 1998.

REFERENCES

1. P.Radhakrishnan, “Computer Numerical Control ", New Central Book Agency, 1992.
2. Groover and Zimmers, " CAD / CAM : Computer Aided Design and Manufacturing Prentice Hall of India, New Delhi, 1994.

E-REFERENCES

1. http://nptel.iitm.ac.in/video.php?subjectId=112102101

2.http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Aided%20Design%20&%20ManufacturingI/index.htm

3.http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Aided%20Design%20&%20ManufacturingII/index.htm

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	1	3	1	1	2	2	3	3	
CO2	3	2	2	3	3	1	3	1	1	3	2	3	3	
CO3	3	2	2	3	2	1	3	1	1	3	2	3	3	
CO4	3	2	2	3	3	1	3	1	1	2	2	3	3	
CO5	3	3	2	3	2	1	3	1	2	3	3	3	3	
Total	15	11	10	15	12	5	15	5	6	13	11	15	15	

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**KINEMATICS AND THEORY OF MACHINES**
Subject Code	**XME505**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 1 – 0– 4	**4:0:0**	**3- 1– 0– 4**

Course Outcome		**Domain/Level C or P or A**
CO1	To understand the kinematics and rigid- body dynamics of kinematically driven machine	C (Understand),
CO2	To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link	C (Understand)
CO3	To be able to design some linkage mechanisms and cam systems to generate specified output motion	C (Apply)
CO4	To understand the kinematics of gear trains	C (Understand)
CO5	To understand the friction mechanisms in bearing clutches and brakes	C (understand)

Objectives:

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

COURSE CONTENT

UNIT I	**BASICS OF MECHANISMS**	**9+3 hrs**

Classification of mechanisms-Basic kinematic concepts and definitions-Degree of freedom, mobility-Grashof's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions-Mechanical advantage-Transmission angle-Description of some common mechanisms-Quick return mechanism, straight line generators-Universal Joint-Rocker mechanisms

UNIT II	**KINEMATICS OF PLANE MECHANISMS**	**9+3 hrs**

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using

loop closure equations kinematic analysis of simple mechanisms- slider crank mechanism dynamics-Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation

UNIT III CAMS 9+3 hrs

Classification of cams and followers-Terminology and definitions Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, Graphical and analytical disc cam profile synthesis for roller and flat face followers.

UNIT IV GEARS 9+3 hrs

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics

UNIT V FRICTION IN BEARING CLUTHES AND BRAKES 9+3 hrs

Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes

L = 45 hrs T = 15hrs Total = 60 hrs

TEXT BOOKS

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.

REFERENCES

1. Rao.J.S. and Dukkipati.R.V. 'Mechanisms and Machine Theory', Wiley-Eastern Ltd., New Delhi, 2003.

2. John Hannah and Stephens R.C., 'Mechanics of Machines', Viva Low-Prices StudentEdition, 2003.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	2	1	-	2	1	-	2	3	2	
CO2	3	2	3	-	2	1	-	2	1	-	2	3	2	
CO3	3	2	3	-	2	1	-	1	1	-	2	3	2	
CO4	3	2	3	-	3	1	-	2	2	-	2	3	2	
CO5	3	2	2	-	3	1	-	2	1	-	2	3	2	

	15	**9**	**12**	**-**	**12**	**5**	**-**	**9**	**6**	**-**	**10**	**15**	**10**	

1 - Low, 2 – Medium, 3- High

Semester	**V**		
Subject Name	**Constitution of India**		
Subject Code	**XUM506**		
L –T –P –C		**C:P:A**	**L –T –P –H**
2- 0 – 0– 0		**0:0:0**	**2- 0– 0 – 2**
Course Outcome			**Domain/Level** **C or P or A**

COURSE CONTENT

		CO Relation
1.	Meaning of the constitute	
2.	on law and constitutionalism	
3.	Historical perspective of the Constitution of India	
4.	Salient features and characteristics of the Constitution of India	
5.	Scheme of the fundamental rights	
6.	The scheme of the Fundamental Duties and its legal status	
7.	The Directive Principles of State Policy – Its importance and implementation	
8.	Federal structure and distribution of legislative and financial powers between the Union and the States	
9.	Parliamentary Form of Government in India – The constitution powers and status of the President of India	
10.	Amendment of the Constitutional Powers and Procedure	

11. The historical perspectives of the constitutional amendments in India

12. Emergency Provisions :National Emergency, President Rule, Financial Emergency

13. Local Self Government – Constitutional Scheme in India

14. Scheme of the Fundamental Right to Equality

15. Scheme of the Fundamental Right to certain Freedom under Article 19

16. Scope of the Right to Life and Personal Liberty under Article 21.

TEXT BOOKS

1. Introduction to Constitution of India, D.D. Basu, Lexis Nexus
2. The Constitution of India, PM Bhakshi, Universal Law

Semester	**V**
Subject Name	**Mechanical engineering laboratory (Thermal) I**
Subject Code	**XME507**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 2	**0:2:0**	**0- 0– 4 – 4**

Course Outcome	**Domain/Level C or P or A**
Measure various properties of fluids using equipments.	Coginitive (Understanding) Psychomotor (Guided response)
Characterize the performance of various fluid machineries.	Coginitive (Understanding) Psychomotor (Guided response)
Determine the various thermal properties.	Coginitive (Understanding) Psychomotor (Guided response)
Identify the Performance of the engines and ***Analyze*** the heat transfer	Coginitive

coefficients in different modes.	(Understanding) Psychomotor (Guided response)
Determine and ***Experimen***t with emissivity and vapour compression system.	Coginitive (Understanding) Psychomotor (Guided response)

Objectives:

(i) To understand the principles and performance characteristics of flow and thermal devices

(ii) To know about the measurement of the fluid properties

COURSE CONTENT

		CO Relation
1.	Measurement of Coefficient of Discharge of given Orifice and Venturi meters	CO1
2.	Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe	CO1
3.	Determination of the performance characteristics of a centrifugal pump	CO2
4.	Determination of the performance characteristics of Pelton Wheel	CO2
5.	Determination of the performance characteristics of a Francis Turbine	CO2
6.	Determination of the performance characteristics of a Kaplan Turbine	CO2
7.	Determination of the thermal conductivity and specific heat of given objects	CO3
8.	Determination of the calorific value of a given fuel and its flash & fire points	CO3
9.	Determination of the p-V diagram and the performance of a 4-stroke diesel engine	CO4
10.	Determination of the convective heat transfer coefficient for flow over a heated plate	CO4
11.	Determination of the emissivity of a given sample	CO5
12.	Determination of the performance characteristics of a vapour compression system	CO5

TEXT BOOKS

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 2003.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.
3. A. Bejan, Heat Transfer John Wiley, 1993
4. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
5. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
6. Rajput, R.K., Thermal Engineering, 6th Edition, Laxmi Publications, 2007
7. Ballaney, P.L., "Thermal Engineering" , Khanna Publishers, 24th Edition, 2003.
8. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.

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1. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 2008.

2. Som, S.K., and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2004.

3. Rudramoorthy, R., Thermal Engineering, 4th Edition, Tata McGraw Hill, New Delhi, 2006.

4. Kothandaraman , C.P., Domkundwar .S and A.v. Domkundwar", a course in thermal Engineering", Dhanpal Rai & sons, fifth edition, 2002.

5. Nag P.K, " Heat Transfer", Tata McGraw-Hill, New Delhi, 2011.

6. R.B.Mathur and R.P. Sharma, Internal combustion Engines.

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1.http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1		3
CO2	2	3	-	2	1	1	-	-	-	-	-	1		3
CO3	2	3	-	2	1	1	-	-	1	-	-	1		3
CO4	2	3	2	1	1	1	-	-	1	-	-	1		3
CO5	2	3	-	2	1	1	-	-	-	-	-	1		3
	10	15	2	9	5	5			3			5		15

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**Inplant Training – II**
Subject Code	**XME508**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 0	**0:2:0**	**0- 0– 2 – 0**

Course Outcome	Domain/Level C or P or A

Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

XMEM01 CNC Programming for Lathe Operations L T P C

0 0 2 0

CNC Machines

Numerical control – definition – components of NC systems, Development of NC, DNC, CNC, and adaptive control systems, Working principle of a CNC system, features and advantages of CNC machines Introduction to CNC systems - Fanuc OI, Siemens 840D, Heidenhein, current trends in programming, Human Machine Interface software – Siemens – Fanuc systems

CNC Hardware System

CNC system elements, Drives, Slide ways, Feedback devices, ATC and Tool Magazines, and Machine Control Units

CNC Part Programming for lathe operations

Part program structure, CNC program procedure – coordinate system, Sequence number, preparatory functions and G codes, miscellaneous functions and M codes, NC dimensioning – reference points – machine zero, work zero, tool zero and tool offsets, Types of motion control: point-to-point, paraxial and contouring Part Program – tool information – speed – feed data – interpolations, Macro – subroutines – canned cycles - Mirror images –Sample programs for lathe operations , Conversational automatic programming, and APT programming- Introduction to Computer assisted part programming – EdgeCAM, Master CAM etc.,

Semester	**VI**
Subject Name	**Economics for Engineers**
Subject Code	**XUM601**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 - 0 – 0– 3	**2.64:0.24:0.12**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Explain*** the concepts of economics in engineering and ***identify*** element of cost to prepare cost sheet	C(Understand) P(Perception)
CO2	***Calculate and Explain*** the Break-even point and marginal costing	C(Apply, Understand) P(Perception)
CO3	***Summarize*** and ***Use*** value engineering procedure for cost analysis	C(Understand) A(Receive)
CO4	***Estimate*** replacement problem	C(Understand)
CO5	***Compute, Explain*** and ***make Use of*** different methods of depreciation	C(Understand, Apply)

COURSE CONTENT

UNIT I	**INTRODUCTION TO ECONOMICS**	**8 hrs**

Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- types of costing, element of costs, preparation of cost sheet and estimation, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost

UNIT II	**BREAK-EVEN ANALYSIS&SOCIAL COST BENEFIT ANALYSIS**	**12 hrs**

Margin of Safety, Profit, Cost & Quantity analysis-Product Mix decisions and CVP analysis, Profit/Volume Ratio (P/V Ratio), Application of Marginal costing, Limitations

Social Cost Benefit Analysis: compare different project alternatives, Calculate direct, indirect and external effects; Monetizing effects; Result of a social cost benefit analysis.

UNIT III	**VALUE ENGINEERING &COST ACCOUNTING**	**10 hrs**

Value engineering – Function, aims, Value engineering procedure - Make or buy decision

Business operating costs, Business overhead costs, Equipment operating costs

UNIT IV	**REPLACEMENT ANALYSIS**	**7 hrs**

Replacement analysis –Types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset.

UNIT V	**DEPRECIATION**	**8 hrs**

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the year's digits method of depreciation, sinking fund method of

depreciation, Annuity method of depreciation, service output method of depreciation.

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Sp Gupta, Ajay Sharma & Satish Ahuja, "Cost Accounting", V K Global Publications,

Faridabad, Haryana, 2012

2. S.P.Jain&Narang, "Cost accounting – Principles and Practice", Kalyani Publishers,

Calcutta, 2012

3. PanneerSelvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi,

2001.

4. William G.Sullivan, James A.Bontadelli& Elin M.Wicks, "Engineering Economy",

Prentice Hall International, New York, 2001.

REFERENCES

1. Luke M Froeb / Brian T Mccann, " Managerial Economics – A problem solving approach" Thomson learning 2007
2. Truett&Truett, "Managerial economics- Analysis, problems & cases " Wiley India 8th edition 2004.
3. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
4. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002

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Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	0	1	0	0	1	1	1	2	2	3
CO2	2	2	1	2	0	0	2	1	1	2	3	3
CO3	2	2	1	3	0	0	2	2	1	2	2	3
CO4	1	2	1	2	0	0	0	1	1	1	2	3
CO5	1	2	0	1	0	0	1	1	0	1	2	3
Total	7	10	3	9	0	0	6	6	4	8	11	15

1 - Low, 2 – Medium, 3- High

Semester	**VI**
Subject Name	**Manufacturing Technology**
Subject Code	**XME 602**

L –T –P –C	**C:P:A**	**L –T –P –H**
4- 0 – 0– 4	**4:0:0**	**4- 0– 0 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	**Construct** the Degrees of freedom, principles of location and clamping, principles of jig design, fool proofing, elements of jigs, locates fixture design	C(Creating) A(Receiving)
CO2	**Explain** the basic principles of measurements classify the various linear and angular measuring equipments and **distinguish** their principle of operation and applications.	C (Evaluating) P (Perception)
CO3	***Explain*** the Assembly of different components	C (Remembering)
CO4	***Explain*** and demonstrate the basic concepts of PERT- CPM and their applications in product planning control.	C (Understand)
CO5	***Explain*** the basic concepts of optimization and To F***ormulate*** and Solve linear programming problems.	C (understand)

Objectives

(i) To provide knowledge on machines and related tools for manufacturing various components.

(ii) To understand the relationship between process and system in manufacturing domain.

(iii) To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

COURSE CONTENT

UNIT I JIGS, FIXTURES AND PRESS TOOLS 12 hrs

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design

UNIT II FORM MEASUREMENT 16 hrs

Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as microscale machining, Inspection and workpiece quality

UNIT III ASSEMBLY PRACTICES 6 hrs

Manufacturing and assembly, process planning, selective assembly, Material handling and

devices

UNIT IV LINEAR MODELS,PROJECT SCHEDULING BY PERT-CPM 8 hrs

Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Travelling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks: CPM and PERT, critical path scheduling

UNIT V Production planning& control 8 hrs

Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models

L = 50 hrs T = 0 hrs P=0hrs Total = 50 hrs

TEXT BOOKS

1. Donaldson C and Le Cain C H, "Tool Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.

2. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2005

3.Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014

4. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.

5. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

6.Automation, Production Systems, & CIM by Grover; Prentice Hall 2. CAD CAM by C. McMahon and J. Browne; published by Addison-Wesley.

REFERENCES

1. Bhattacharyya A, “Metal Cutting Theory and Practice”, New Central Books Agency (P) Ltd, Calcutta, 2000.

2. Fundamentals of Operations Research, Advanced Operation Research Prof.G.Srinivasan, Department of Management Studies, Indian Institute of Technology, Madras.

3.Modern Production/ Operations Management, E. S. Buffa and R. K. Sarin, John Wiley International, 1994.

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Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	-	-	1	-	-	1	3	
CO2	2	2	-	-	-	1	1	-	-	-	-	1	3	

CO3	2	1	-	-	2	1	1	-	-	-	-	1	3	
CO4	2	1	-	-	1	1	1	-	1	-	-	1	3	
CO5	1	-	-	-	1	1	-	-	1	-	-	1	3	
Tot	9	5			4	5	3	3				5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VI**	
Subject Name	**Design of Machine Elements**	
Subject Code	**XME603**	
L –T –P –C **3 – 1 – 0– 4**	**C:P:A** **3:1:0**	**L –T –P –H** **3–1– 0 – 4**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Describe the design process, material selection, calculation of stresses and stress concentrations under variable loading.	C (Understand)
CO2	Design the solid, hollow shafts and to finding the critical speeds also have a design knowledge on sliding and rolling contact bearing	C (Synthesis)
CO3	Summarize the knowledge in helical, leaf, disc and torsional springs	C (Understand)
CO4	Analyze bolted joints in eccentric loading. Examine the welded joints for vessels and steel structures. Differentiate rigid and flexible couplings and also the knuckle joints.	C (Analysis)
CO5	Recognize the need for friction drives and positive drives. Apply BIS standards and catalogues in design and selection of belts and chain for requirement, Select suitable drive combination based on requirement.	C (Understand)

Objectives

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

- A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
- An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
- An overview of codes, standards and design guidelines for different elements
- An appreciation of parameter optimization and design iteration
- An appreciation of the relationships between component level design and overall machine system design and performance

COURSE CONTENT		
UNIT I	**Steady Stresses and Variable Stresses in Machine Members**	**6+0**
	design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure)	
UNIT II	**Shafts and bearings**	**9+3**
	design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings	
UNIT III	**Energy storing Elements**	**6+3**
	helical compression, tension, torsional and leaf springs	
UNIT IV	**Temporary and Permanent Joints**	**9+3**
	threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings	
UNIT V	**Transmission elements**	**15+6**
	spur, helical, bevel and worm gears; belt and chain drives, Analysis of clutches and brakes	
L =45 hrs T=15hrs Total = 60 hrs		

TEXT BOOKS

[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.

[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.

REFERENCES

[1] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.

[2] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994. [5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

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Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	2	1	2	2	1	2	2	2	2	
CO2	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO3	3	2	3	1	2	1	2	2	1	2	2	2	2	

CO4	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO5	3	2	2	1	2	1	2	2	1	2	2	2	2	
	14	10	14	6	10	5	10	10	5	10	10	10	10	

1 - Low, 2 – Medium, 3- High

Semester	**VI**
Subject Name	**Mechanical engineering laboratory (Design) II**
Subject Code	**XME606**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 4– 2	**0:2:0**	**0- 0– 4 – 4**

Course Outcome	**Domain/Level** **C or P or A**
Define different mechanical properties and ***solve*** various deformation problems under different stress and loading conditions.	Coginitive (Remembering) (Applying) Psychomotor (Guided response)
Indentify Strain for various objects.	Coginitive (Understanding) Psychomotor (Guided response)
Examine the molecular structures of heat treated samples.	Coginitive (Understanding) Psychomotor (Perception)
Study about various velocity ratios, kinematic mechanisms and cam –follower motions.	Coginitive (Understanding) Psychomotor (Guided response)
Determine the frequencies of various kinematic systems.	Coginitive (Understanding) Psychomotor (Guided response)

Objectives

(i) To understand the measurement of mechanical properties of materials

(ii) To understand the deformation behavior of materials

(iii) To understand the kinematic and dynamic characteristics of mechanical devices

COURSE CONTENT

		CO Relation
1.	Uniaxial tension test on mild steel rod	CO1

2.	Torsion test on mild steel rod	CO1
3.	Impact test on a metallic specimen	CO1
4.	Brinnell and Rockwell hardness tests on metallic specimen	CO1
5.	Bending deflection test on beams	CO1
6.	Strain measurement using Rosette strain gauge	CO2
7.	Microscopic examination of heat-treated and untreated metallic samples	CO3
8.	Velocity ratios of simple, compound, epicyclic and differential gear trains	CO4
9.	Kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms	CO4
10.	Cam & follower and motion studies	CO4
11.	Single degree of freedom Spring-mass-damper system, determination of natural frequency and damping coefficient	CO5
12.	Determination of torsional natural frequency of single and double rotor systems- undamped and damped natural frequencies	CO5

TEXT BOOKS

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. S. Ramamrutham and R. Narayanan, (2003), Strength of Materials, Dhanpat Rai Publications.
4. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
5. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
6. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.

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1. Rowland Richards, (2000), Principles of Solid Mechanics, CRC Press.

2.Timoshenko, S.P. and Young, D.H., (2000), Strength of Materials, East West Press Ltd

3. R.K. Bansal, (2000), Strength of Materials, Laxmi Publications

4. James F Shackelford, S "Introduction to materials Science for Engineers", 6 th Macmillan Publishing Company, New York, 2004.

5. Ghosh.A, and A.K.Mallick, 'Theory of Mechanisms and Machines', Affiliated East-West Pvt. Ltd., New Delhi, 2007.

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1.NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering &Metallurgy and Material Science categories

2.http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO2	2	3	-	2	1	1	-	-	-	-	-	1	2	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO4	2	3	2	1	1	1	-	-	1	-	-	1	2	
CO5	2	3	-	2	1	1	-	-	-	-	-	1	2	
Tot	10	15	2	9	5	5			3			5	10	

XMEM02 **Pneumatics and Hydraulics** **L T P C**

0 0 2 0

S.No	Theory Session	Lab Session
1.	Introduction about Automation	Basic Hydraulics and Hydraulic equipments such as Pumps, motor, Cylinders, Check valves, Direction control valves
2.	Basic Hydraulics and Hydraulic equipments: Pilot operated check valves, throttle valves, solenoid valves, etc.,	**Hydraulic Lab**: Simple hydraulic circuits using hydraulic equipments, cylinder and motor by manual operation
3.	Development of Hydraulic circuits using Check valves, direction control valves, Pilot operated check valves, throttle valves etc.,	**Hydraulic Lab**: Hydraulic circuits using Check valves, throttle valve, meter in and meter out circuits
4.	Working principles of solenoid valves, Relay and development of relay logic circuits	**Hydraulic Lab**: Hydraulic circuits using relay logic

5.	Timers : Switch On delay and Switch off delay	**Hydraulic Lab:** Hydraulic circuits using on delay and off delay
6.	Sensors: Different types of Proximate sensors	**Sensoric Lab:** Identification of metal and non metal using sensors, Calculation of range of sensors.
7.	Development of hydraulic circuits using sensors	**Hydraulic Lab:** Hydraulic circuits using sensors
8.	Pressure Switches	**Hydraulic Lab:** Hydraulic circuits using Pressure switch
9.	Development of hydraulic circuits by Combination of two cylinders	**Hydraulic Lab:** Sequential hydraulic circuits using two cylinders
10.	Introduction about Pneumatics	Basic Pneumatics and Pneumatics equipments such as Pumps, motor, Cylinders, Check valves, Direction control valves
11.	Basic Pneumatics and Pneumatics equipments: Pilot operated check valves, throttle valves, solenoid valves, etc.,	**Pneumatics Lab**: Simple Pneumatics circuits using Pneumatics equipments, cylinder and motor by manual operation
12.	Development of Pneumatics circuits using Check valves, direction control valves, Pilot operated check valves, throttle valves etc.,	**Pneumatics Lab**: Pneumatics circuits using Check valves, throttle valve, meter in and meter out circuits
13.	Working principles of solenoid valves, Relay and development of relay logic circuits	**Pneumatics Lab**: Pneumatics circuits using relay logic
14.	Timers : Switch On delay and Switch off delay	**Pneumatics Lab:** Pneumatics circuits using on delay and off delay
15.	Sensors: Different types of Proximate sensors	**Sensoric Lab:** Identification of metal and non metal using sensors, Calculation of range of sensors.
16.	What is PLC?	Basic concepts of PLC *Graphical Symbols of Pneumatics Circuits,* Working of PLC & General

		Applications
17.	Indra control PLC's – Technical Details	Hardware Details of L10/L20 Documentation provided in CD Related Software for PLC
18.	Related Software for PLC	**Detailed presentation on inline products,** Technical & hardware details on -digital I/O -analog I/o -Bus couplers -Function modules
19.	Indra works Software Installation	Indraworks Software features explanation in detail , Indralogic standard settings, Project development in Indraworks Hardware Configuration
20.	Project Development in Indra logic	Logic Development - Ladder Diagram - Addressing of Digital I/O's Creating Parallel Paths (Network) - Programming Language Selection/Conversion
21.	Logic Development - Variable Declaration (Local/Global) - Declaration in Tabular Format	- Function Blocks (Timers, Counters etc.) - Exercises Segregation of programs based on functionality or application
22.	Set ,Reset concepts - Exercises	**Communication parameters settings**

23.	Logic Development - Addressing Digital I/O's	Working with Digital I/O's, Configuring Digital I/O's , - Exercises
24.	Exercise	Exercise
25.	Exercise	TesT And feedback session
26.	Introduction to Sensorics What are Sensors? Classification of Sensors Different types of sensors used in Automation Technologies Characteristics of Inductive, Capacitive, Ultrasonic, Photo electric and Magnetic proximity sensors Comparison of sensors	Experiment 01 : Behavior of the capacitive sensor
27.	Behavior of resistive sensors	Behavior of inductive sensor
28.	Role of the Sensors in Mechatronixcs, Robotics and Automation	Real time problems and solutions
29.	Exercise	Experiment 01 : Behavior of the capacitive sensor
30.	Test And feedback session	

Semester	**VII**		
Subject Name	**Cyber Security**		
Subject Code	**XUM706**		
L –T –P –C		**C:P:A**	**L –T –P –H**
3 – 0 – 0– 0		**3:0:0**	**3–0– 0 – 3**
Course Outcome			**Domain/Level** **C or P or A**
CO1	Able to ***understand*** the Cyber Security Policy, Laws and Regulations		C(Remember)

CO2	Able to ***discuss*** the Cyber Security Management Concepts	C(Understand)
CO3	Able to ***understand*** *t*he Cyber Crime and Cyber welfare	C(Understand)
CO4	Able to ***discuss*** on issues related to Information Security Concepts	C(Understand)
CO5	Able to ***understand*** various security threats	C(Understand)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**

Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges

UNIT II	**CYBER SECURITY OBJECTIVES AND GUIDANCE**	**9hrs**

Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project– Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.

UNIT III	**CYBER SECURITY POLICY CATALOG**	**9 hrs**

Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation – Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare

UNIT IV	**INFORMATION SECURITY CONCEPTS**	**9 hrs**

Information Security Overview: Background and Current Scenario - Types of Attacks - Goals for Security - E-commerce Security - Computer Forensics – Steganography

UNIT V	**SECURITY THREATS AND VULNERABILITIES**	**9 hrs**

Overview of Security threats -Weak / Strong Passwords and Password Cracking - Insecure Network connections - Malicious Code - Programming Bugs - Cyber crime and Cyber terrorism - Information Warfare and Surveillance

L = 45 hrs Total = 45 hrs

REFERENCES

1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.
2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
3. Richard A. Clarke, Robert Knake "Cyberwar: The Next Threat to National Security & What to Do About It" Ecco 2010
4. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011
5. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-

E REFERENCE

1. https://www.coursera.org/specializations/cyber-security
2. www. nptel.ac.in
3. http://professional.mit.edu/programs/short-programs/applied-cybersecurity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1	3	2	2	3	0	1	2	0	1	0	1	1
CO 2	3	2	1	3	0	1	2	0	1	0	1	1
CO 3	3	2	1	3	0	1	2	1	1	0	1	1
CO 4	3	2	1	2	0	1	2	1	1	0	1	1
CO 5	3	2	1	2	0	1	2	0	1	0	1	1
Tot	15	10	6	13	0	5	10	2	5	0	5	5

1 - Low, 2 – Medium, 3- High

Semester	**VII**	
Subject Name	**Automation in manufacturing**	
Subject Code	**XME702**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

	Course Outcome	**Domain/Level C or P or A**
CO1	Define automation and classify different types of automation along with recent trends of automation in manufacturing.	C (Rem), C(U)
CO2	Classify and describe computer aided technologies in manufacturing.	C (Rem), C(U)
CO3	Classify and explain different automation technologies and building blocks of systems.	C (Rem), C(U)

CO4	Describe product modelling and simulation techniques in manufacturing	C (Rem), C(U)
CO5	Define additive manufacturing and explain the recent advancements in additive manufacturing.	C (Rem), C(U)

Objectives

1. To understand the importance of automation in the of field machine tool based manufacturing

2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC

3. To understand the basics of product design and the role of manufacturing automation

COURSE CONTENT

UNIT I BASIC CONCEPTS AND PROPERTIES OF FLUIDS 9 hrs

Introduction: Why automation- Current trends-CAD, CAM, CIM- Rigid automation- Part handling, Machine tools- Flexible automation- Computer control of Machine Tools and Machining Centers-NC and NC part programming, CNC-Adaptive Control- Automated Material handling. Assembly-Flexible fixturing.

UNIT II COMPUTERS IN MANUFACTURING 9hrs

Computer Aided Design- Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base-Geometric modelling for downstream applications and analysis methods- Computer Aided Manufacturing- CNC technology- PLC- Micro-controllers-CNC-Adaptive Control

UNIT III AUTOMATION 9 hrs

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

UNIT IV MODELLING AND SIMULATION 9 hrs

Introduction to Modelling and Simulation-Product design- process route modelling-Optimization techniques-Case studies & industrial applications.

UNIT V Additive Manufacturing 9 hrs

Additive Manufacturing-3Dprinting-Classification of 3D printers-components of basic 3D printer-Preparation of geometry for 3D printing-STL, STEP file generation-Managing of inter exchangeable formats for 3D printing, open source resources for 3D printing.

L = 45 hrs Total = 45 hrs

TEXT BOOKS

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.

2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson

REFERENCES

1. Yoram Koren, Computer control of manufacturing system, 1st edition.

2. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

E-REFERENCES

https://nptel.ac.in/courses/112102011/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	1	-	-	-	1	-	-	-	3	
CO2	3	2	-	2	1	-	-	-	1	-	1	1	3	
CO3	3	1	-	1	1	-	-	1	1	-	1	1	3	
CO4	3	2	-	2	1	-	-	-	1	-	-	-	3	
CO5	3	3	3	3	2	-	-	2	1	-	3	3	3	
	15	10	3	10	6			3	5		5	5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VII**
Subject Name	**Mechanical engineering laboratory (Manufacturing) III**
Subject Code	**XME707**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 4– 2	**0:2:0**	**0- 0– 4 – 4**

Course Outcome	**Domain/Level** **C or P or A**
Experiment and ***Measure*** various machining operations and its cutting forces involved.	Coginitive (Remembering) (Applying) Psychomotor (Guided response) (Perception)
Create and **choose** the CNC suitable part programming for the corresponding job.	Coginitive (Understanding) Psychomotor

	(Guided response)
Experiment the sample with EDM.	Coginitive (Understanding) Psychomotor (Perception)
Understand the operation of pick and place robot.	Coginitive (Understanding) Psychomotor (Guided response)
Explain the basic principles of measurements classify the various linear and angular measuring equipments and **distinguish** their principle of operation and applications.	Coginitive (Evaluating) Psychomotor (Perception)

Objectives

1. To provide an understanding of advanced manufacturing methods.

2. To get an idea of the dimensional & form accuracy of products

COURSE CONTENT

		CO Relation
1.	Taper turning and external thread cutting using lathe	CO1
2.	Contour milling using vertical milling machine	CO1
3.	Spur gear cutting in milling machine	CO1
4.	Measurement of cutting forces in Milling/ Turning process	CO1
5.	CNC part programming	CO2
6.	Drilling of a small hole using wire EDM	CO3
7.	Microprocessor controlled pick & place robot	CO4
8.	Use of Tool Maker's Microscope	CO5
9.	Comparator and sine bar	CO5
10.	Surface finish measurement equipment	CO5
11.	Bore diameter measurement using micrometer and telescopic gauge	CO5
12.	Use of Autocollimator	CO5

TEXT BOOKS

1. Hajra Choudhury S.K and Hajra Choudhury. A.K., "Elements of Workshop Technology, Volume I and II", Media Promoters and Publishers Private Limited, Mumbai.
2. HMT – "Production Technology", Tata McGraw-Hill, 1998.Dr. B.C.Punmia, "Surveying – Volume I", Laxmi Publications, New Delhi, 2005

3. Jain R.K., "Engineering Metrology", Khanna Publishers, 2005

4. Mikell. P. Groover, Automation Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India Ltd., New Delhi, 1998.

5. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2007.

REFERENCES

1. Paul Degarma E, Black J.T. and Ronald A. Kosher, Materials and Processes, in Manufacturing Prentice – Prentice Hall of India.
2. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd.,
3. Milton C.Shaw, 'Metal Cutting Principles', Oxford University Press, Second edition,2005.
4. Rao, P.N. "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw–Hill, New Delhi, 2003.

5. Gupta S.C, "Engineering Metrology", Dhanpat rai Publications, 2005

6. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, (1994).

7. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.

E-REFERENCES

1.http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO2	2	3	-	2	1	1	-	-	-	-	-	1	3	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO4	2	3	2	1	1	1	-	-	1	-	-	1	3	
CO5	2	3	-	2	1	1	-	-	-	-	-	1	3	
Tot	10	15	2	9	5	5			3			5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VII**	
Subject Name	**Project phase – I**	
Subject Code	**XME708**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 8– 4	**0:8:0**	**0- 0– 8 – 8**
Course Outcome		**Domain/Level**
		C or P or A

Objectives:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

Semester	**VII**	
Subject Name	**Inplant Training - III**	
Subject Code	**XME709**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 4– 2	**0:4:0**	**0- 0– 4 – 4**
Course Outcome		**Domain/Level**
		C or P or A

Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Total hrs – 90

XMEM03 **Non Destructive Testing** **L T P C**

0 0 2 0

Introduction and Radiography

Introduction to NDT – need – advantages and limitations Radiography – Sources – IR192, cobalt 60 – X-ray film – processing – testing methods – film interpretation

Ultrasonic testing

A,B,C scan, immersion Testing, Normal and Angle Probe Testing

Magnetic particle

Testing Methods – particles - wet, dry and fluorescent

Dye penetrant testing

Surface preparation –Testing procedure - types of penetrant.

Other NDT methods

Thermography, Image processing TOFD and Phased Array - leak testing – Halogen, Helium

Semester	**VIII**	
Subject Name	**Project phase – II**	
Subject Code	**XME804**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 6– 6	**0:6:0**	**0- 0– 12 – 12**

Course Outcome	**Domain/Level C or P or A**

Objectives:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

PROFESSIONAL ELECTIVES SYLLABUSES

Semester	**TRACK – I**	
Subject Name	**Gas Dynamics and Shock Waves**	
Subject Code	**XMEE01**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define and apply*** energy and Momentum equations for compressible flows ***Explain and apply*** regions of flow, reference velocities. Mach number	C(Remember, Understand, Apply)
CO2	***Define*** Isentropic flow through variable area ducts ***Explain and apply*** T-s and H-s diagrams for nozzle and diffuser flows, mass flow rate through nozzles and diffusers	C(Remember, Understand, Apply)
CO3	***Define*** fanno flow and Rayleigh flow equations ***Explain and apply*** variation of flow properties**,** Mach number with duct length,	C(Remember,

	maximum heat transfer for Rayleigh fow	Understand, Apply)
CO4	**Define** Normal shock governing equations ***Explain and apply*** Prandtl Meyer equation, Flow in convergent and divergent nozzle, Fanno flow and Rayleigh flow with normal shock	C(Remember, Understand, Apply)
CO5	***Explain*** Aircraft and rocket propulsion ***classify*** Jet engines for aircraft and rocket propulsion **apply** performance Jet engines for aircraft and rockets	C(Remember, Understand, Apply)

COURSE CONTENT

UNIT I	**COMPRESSIBLE FLOW – FUNDAMENTALS**	**6+6 hrs**

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility

UNIT II	**FLOW THROUGH VARIABLE AREA DUCTS**	**6+6 hrs**

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

UNIT III	**FLOW THROUGH CONSTANT AREA DUCTS**	**6+6hrs**

Flow in constant area ducts with friction (Fanno flow) – Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. flow with friction in constant area ducts Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

UNIT IV	**NORMAL SHOCK**	**6+6 hrs**

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl - Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flow with oblique shock (elementary treatment only).

UNIT V	**PROPULSION**	**6+6 hrs**

Aircraft propulsion – types of jet engines – energy flow through jet engines, performance of turbo jet engines – thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines

Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants, comparison of different propulsion systems.

L = 30 hrs T – 30 hrs Total = 60 hrs

TEXT BOOKS

1. Yahya. S.M., “Fundamental of compressible flow”, Third Edition, 2003New Age International (p) Ltd., New Delhi, 1996
2. Patrich.H. Oosthvizen, William E.Carscallen, “Compressible fluid flow”, McGraw-Hill, 1997

REFERENCES

1. Cohen. H., Rogers R.E.C and Sravanamutoo, “Gas turbine theory”, Addison Wesley Ltd., 1987
2. Yahya. S.M., Fundamentals of Compressible flow with Aircraft and Rocket Propulsion, 2003New Age International (p) Ltd., New Delhi
3. Ganesan. V., “Gas Turbines”, Tata McGraw-Hill, New Delhi, 1999.
4. Rathakrishnan.E, “Gas Dynamics”, Prentice Hall of India, New Delhi, 2001
5. Shock Wave Society, IISc. CD Material Released on NSSW2,27 & 28 Feb,2012

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http://nptel.iitm.ac.in/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	2	3	-	2	-	-	2	2	3		3
CO2	3	1	-	2	3	-	2	-	-	2	2	3		3
CO3	3	-	-	1	2	-	1	-	-	1	-	2		3
CO4	2	-	-	1	2	-	1	-	-	1	-	1		3
CO5	3	2	-	2	3	-	2	-	-	1	2	2		3
	14	4	-	8	13	-	8	-	-	7	6	11		15

1 - Low, 2 – Medium, 3- High

Semester	**TRACK – I**
Subject Name	**POWER PLANT ENGINEERING**
Subject Code	**XMEE02**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	What are the types of thermal power plants, systems operation and handling and cogeneration systems?	C(Rem), (Understend)
CO2	Describe gas turbine and combined cycle power plants systems components and operation	C (Rem) (Understand)

CO3	How nuclear energy conversion, nuclear power plant subsystems works and types of nuclear reactors.	C (Rem) (Understand)
CO4	What is the potential of exploiting renewable energy systems, and hydro power plant systems and components	C (Understand)
CO5	Extend energy economics and environmental issues of different power plants.	C (understand)

COURSE CONTENT

UNIT I	**THERMAL POWER PLANTS AND SYSTEMS HANDLING**	**12+0+0 hrs**
	Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems	
UNIT II	**GAS TURBINE POWER PLANTS AND COMBINED CYCLE SYSTEMS**	**9+0+0 hrs**
	Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.	
UNIT III	**NUCLEAR ENERGY POWER PLANTS**	**9+0+0 hrs**
	Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	
UNIT IV	**HYDROPOWER PLANT AND RENEWABLE ENERGY SYSTEMS**	**6+0+0 hrs**
	Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems	
UNIT V	**ENERGY ECONOMICSAND ENVIRONMENTAL ISSUES**	**9+0+0 hrs**
	Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.	

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Power plant engineering by Arora and Domkudwar,Dhanpati Rai Publications ,2016
2. Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2017.
3. G.D.Rai, “Non conventional energy sources”, Khanna Publishers, 1995.

REFERENCES

1. K.K. Ramalingam, “Power Plant Engineering”, Scitech Publications, 2002.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010. .

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1. www. nptel.ac.in/courses/108105058/8

1. www.nptelvideos.in/2012/11/energy-resources-and-technology.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**-**	**-**	**3**	**1**	**2**	**-**	**-**	**2**	**-**	**-**	**1**		**3**
CO2	**3**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**		**3**
CO3	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**-**		**3**
CO4	**3**	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**1**		**3**
CO5	**3**	**-**	**-**	**1**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**		**3**
	13			**9**	**9**	**8**			**7**		**1**	**3**		**15**

1 - Low, 2 – Medium, 3- High

Semester	**TRACK – I**	
Subject Name	**REFRIGERATION AND AIR CONDITIONING**	
Subject Code	**XMEE03**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	To familiarize with the terminology associated with refrigeration systems and air conditioning	C (Understand),
CO2	To understand basic refrigeration processes	C (Understand)
CO3	To provide an overview of sorption system	C (Understand)
CO4	To understand the basics of psychrometry and practice of applied psychrometrics	C (Understand apply)

CO5	To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components	C (understand)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**
	Classification of refrigeration systems	
UNIT II	**REFRIGERATION CYCLE**	**9 hrs**
	Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics -Ozone depletion and global warming issues-System components: Compressors, Condensers, Expansion devices and Evaporators-Performance matching of components of refrigeration systems	
UNIT III	**SORPTION REFRIGERATION**	**9 hrs**
	Advanced sorption refrigeration systems and their components.	
UNIT IV	**PSYCHROMETRY**	**9hrs**
	Review of Psychrometry and Air-conditioning processes-Comfort air conditioning and Cooling load calculations	
UNIT V	**REFRIGERATION SYSTEM COMPONENTS**	**9 hrs**
	Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils, Applications of AC systems	

L = 45 hrs Total = 45 hrs

TEXT BOOKS

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

REFERENCES

1. Roy.J Dossat, “Principles of Refrigeration”, Pearson Education 1997.

2. Jordon and Prister, “Refrigeration and Air Conditioning”, Prentice Hall of India PVT Ltd. New Delhi, 1985

3. Stoecker N.F and Jones, "Refrigeration and Air Conditioning", TMH, New Delhi, 1981.

E-REFERENCES- http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	0	0	0	1	0	1	1	0	1	1		3
CO2	3	3	1	0	1	1	0	2	3	1	3	3		3

CO3	3	3	2	1	1	1	0	2	3	2	3	3		3
CO4	3	3	3	0	2	2	1	3	3	2	3	3		3
CO5	1	1	1	0	0	0	0	1	1	1	2	2		3
	13	**11**	**7**	**1**	**4**	**5**	**1**	**9**	**11**	**6**	**12**	**12**		**15**

1 - Low , 2 – Medium , 3- High

Semester	**TRACK – I**
Subject Name	**RENEWABLE ENERGY SOURCES**
Subject Code	**XMEE04**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

	Course Outcome	**Domain/Level C or P or A**
CO1	To know the energy demand of world, nation and available resources to fulfill the demand	C (Understand), A
CO2	To know about the problems associated with the conventional energy resources for sustainable development	C (Understand), A
CO3	To know about the exploration of nonconventional energy resources and their effective tapping technologies	C (Understand), A
CO4	To acquire the knowledge of modern energy conversion technologies	C (Understand apply), A
CO5	Select appropriate energy conservation method to reduce the wastage of energy	C (understand), A

COURSE CONTENT

UNIT I	**ENERGY AND ENVIRONMENT**	**10 hrs**

Primary energy sources - world energy resources - Indian energy scenario - energy cycle of the earth –environmental aspects of energy utilization, CO_2 emissions and global warming, Carbon cycle – renewable energy resources and their importance. Potential impacts of harnessing the different renewable energy resources.

UNIT II	**BIO ENERGY**	**9 hrs**

Energy from bio mass & bio gas plants - various types - design principles of biogas plants - applications. Industrial, municipal and agricultural waste to Energy, Incineration - advantages and limitations – Bio fuels – types, production methods, properties and applications.

UNIT III	**SOLAR ENERGY**	**10 hrs**

Principles of solar energy collection -.solar radiation - measurements - instruments - types

of collectors - characteristics and design principles of different type of collectors - performance of collectors. Solar thermal applications – water heaters and air heaters - performance and applications - simple calculations - solar cooling - solar drying - solar ponds - solar tower - solar furnace.

UNIT IV WIND, TIDAL AND GEO THERMAL ENERGY 9hrs

Energy from the wind - general theory of windmills - types of windmills - design aspects of horizontal axis windmills - applications. Energy from tides and waves – working principles of tidal plants and ocean thermal energy conversion plants - power from geothermal energy - working principle of geothermal power plants

UNIT V ENERGY CONSERVATION AND AUDIT 7 hrs

Energy Conservation, Energy Audit and Energy Management-Principles and Techniques.

L = 45 hrs Total = 45 hrs

TEXT BOOKS

1.. Rai G.D, "Non conventional Energy sources" (1999) Khanna Publishers, New Delhi

2. Duffie and Beckmann, "Solar Energy Thermal Processes, John Wiley, 1974.

REFERENCES

1. Sukhatme, S.P., Solar Energy, 2nd edition, TMH, 2003

2. Sulton, "Direct Energy Conversion", McGraw-Hill, 1966.

3. Garg. H. P and Prakash. J., "Solar Energy - Fundamentals and applications", TMH, New Delhi, 1997.

4. Ashok V Desai, "Non-conventional Energy", Wiley Eastern Ltd, New Delhi, 1990

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	0	0	0	1	0	1	1	0	1	1		3
CO2	3	3	1	0	1	1	0	2	3	1	3	3		3
CO3	3	3	2	1	1	1	0	2	3	2	3	3		3
CO4	3	3	3	0	2	2	1	3	3	2	3	3		3
CO5	1	1	1	0	0	0	0	1	1	1	2	2		3
	13	**11**	**7**	**1**	**4**	**5**	**1**	**9**	**11**	**6**	**12**	**12**		**15**

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-I**
Subject Name	**Advanced I.C.ENGINES**
Subject Code	**XMEE05**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand working and performance of IC Engines through thermodynamic cycles.	C (Rem),
CO2	Outline emission formation mechanism of IC engines, its effects and the legislation standards.	C (Rem)
CO3	Understand working principles of instrumentation used for engine performance and emission parameters.	C (Rem)
CO4	Evaluate methods for improving the IC engine performance.	C (Understand)
CO5	Understand the latest developments in IC Engines and alternate fuels.	C (understand)

COURSE CONTENT

UNIT I	**GAS POWER CYCLES**	**9 hrs**
	Review of ideal cycles; Details of fuel-air cycles.	
UNIT II	**COMBUSTION IN SI AND CI ENGINES**	**9hrs**
	Combustion in SI and CIengines, Combustion stages, Combustion chambers and Abnormal combustion.	
UNIT III	**FUEL SUPPLY SYSTEMS**	**9hrs**
	Fuel supply systemsin SI and CI engines, carburettors, Port fuel injection, Direct injection and Common rail injection.	
UNIT IV	**LUBRICATION SYSTEM**	**9hrs**
	Ignition system, Lubrication system and Cooling system.	
UNIT V	**ENGINE EMISSIONS AND CONTROL**	**9 hrs**
	Testing of IC engines. Engine emissionsand control. Advanced IC Engine concepts.	

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Obert E. F, “Internal Combustion Engines and Air Pollution”, Harper and Row Publication Inc. NY, 1973.
2. Heisler H, “Advanced Engine Technology”, Edward Arnold, 1995.
3. Heywood J. B, “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co. NY, 1989
4. Heldt P. M, “High Speed Combustion Engines”, Oxford & IBH publishing Co. India, 1985.

5. Stockel M W, Stockel T S and Johanson C, “Auto Fundamentals”, The Goodheart, Wilcox Co. Inc., Illinois, 1996.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	1	-	-	1		3
CO2	2	2	-	1	-	1		-	-	-	-	1		3
CO3	2	3	2	2	1	1	1	-	1	-	-	1		3
CO4	1	1	3	-	2	1	1	2	-	-	-	1		3
CO5	1	-	2	3	2	1	1	-	-	-	-	1		3
TOT	9	7	8	7	5	4	3	2	2			5		15

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-I**	
Subject Name	**Energy Conservation and Management**	
Subject Code	**XMEE06**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Remember and *Understand* about the Energy scenarios.	C (Rem),
CO2	*Understand* about the energy conservation techniques.	C (Rem)
CO3	*Understand* about the energy conservation in various thermal applications.	C (Rem)
CO4	*Understand* about the energy conservation in various mechanical applications.	C (Understand)
CO5	*Remember* and *Understand* about energy economics.	C (understand)

COURSE CONTENT

UNIT I	**Introduction**	**9 hrs**

Introduction to energy & power scenario of world, National Energy consumption data, and environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

UNIT II Energy Conservation 9hrs

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

UNIT III Energy conservation in Thermal systems 9hrs

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

UNIT IV Energy conservation in Mechanical systems 9hrs

Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.

UNIT V Energy Economics 9 hrs

Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1.Witte L.C. , Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988..
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
4. Energy Manager Training Manual , Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	1	-	-	1		3
CO2	2	2	-	1	-	1		-	-	-	-	1		3
CO3	2	3	2	2	1	1	1	-	1	-	-	1		3
CO4	1	1	3	-	2	1	1	2	-	-	-	1		3
CO5	1	-	2	3	2	1	1	-	-	-	-	1		3
TOT	9	7	8	7	5	4	3	2	2			5		15

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-II**	
Subject Name	**Finite Element Analysis**	
Subject Code	**XMEE07**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Solve** problems by applying standard finite element techniques	C (Apply)
CO2	**Analyze** 1-D finite elements and to build the stiffness matrix..	C (Analyze)
CO3	**Examine** 2-D finite element continuum for structural applications	C (Analyze)
CO4	**Apply** axisymmetric formulation for specific applications.	C (Apply)
CO5	**Make use of** finite element principles in isoparametric applications.	C (Apply)

COURSE CONTENT

UNIT I	**Introduction**	**9 hrs**
	Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – RitzTechnique – Basic concepts of the Finite Element Method.	
UNIT II	**ONE-DIMENSIONAL PROBLEMS**	**9 hrs**
	One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.	
UNIT III	**TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS**	**9 hrs**
	Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors.Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.	
UNIT IV	**TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS**	**9 hrs**
	Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.	
UNIT V	**ISOPARAMETRIC FORMULATION**	**9 hrs**
	Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements– One and two dimensions – Serendipity elements – Numerical integration and application to planestress problems - Matrix solution techniques – Solutions Techniques	

to Dynamic problems –Introduction to Analysis Software.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.

REFERENCES

1. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002
2. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.
3. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 2000
4. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons,2005 (Indian Reprint 2013)*

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	-	2	-	1	-	1	-	1	1	2	
CO2	3	2	3	1	3	1	1	-	1	1	2	3	2	
CO3	3	2	3	1	3	1	1	-	1	1	2	3	2	
CO4	3	2	3	1	3	1	1	-	1	1	2	3	2	
CO5	3	2	3	1	3	1	1	-	1	1	2	3	2	
TOT	15	9	14	4	14	4	5	-	5	4	9	13	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-II**
Subject Name	**Design of Transmission Systems**
Subject Code	**XMEE08**

L –T –P –C **C:P:A** **L –T –P –H**

3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level** **C or P or A**
CO1	**Recall** the need for friction drives and positive drives and **select** suitable drive.	C (Remember)
CO2	**Design** spur and helical gear by considering strength and life.	C (Create)
CO3	**Estimate** the dimensions of bevel and worm gears	C (Evaluate, Create)
CO4	**Design** of multi-speed gearbox and **construct** ray diagram and kinematic arrangement diagram for multi-speed gearbox.	C (Apply, Create)
CO5	**Apply** the uniform pressure and wear theories to design the various clutches and **Design** braking system for various applications	C (Apply, Create)

COURSE CONTENT

UNIT I	**TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS**	**9 hrs**

Selection of V belts and pulleys – selection of Flat belts and pulleys - Wire ropes and pulleys – Selection of Transmission chains and Sprockets. Design of pulleys and sprockets.

UNIT II	**SPUR GEARS AND HELICAL GEARS**	**9 hrs**

Spur gears - Gear Terminology- Gear materials - Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety. Helical gears – module and Face width-power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses - Estimating the size of the helical gears. Cross helical gears - terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT III	**BEVEL AND WORM GEARS**	**9 hrs**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

UNIT IV	**GEAR BOXES**	**9 hrs**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gear box, synchromesh gear box– Design of multi speed gear box.

UNIT V CAMS, CLUTCHES AND BRAKES 9 hrs

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-internal and external shoe brakes

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.

2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.

3. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.

4. Juvinall R. C., Marshek K.M., "Fundamentals of Machine component Design", – John Wiley & Sons Third Edition, 2006.

5. Bhandari, V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., 2005.

REFERENCES

1. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2005,

2. Norton R.L, "Design of Machinery", McGraw-Hill Book co, 2004.

3. Hamrock B.J., Jacobson B., Schmid S.R., "Fundamentals of Machine Elements", McGraw-Hill Book Co., 2005.

STANDARDS

- IS 4460 : Parts 1 to 3 : 1995, Gears – Spur and Helical Gears – Calculation of Load Capacity.
- IS 7443 : 2002, Methods of Load Rating of Worm Gears
- IS 15151: 2002, Belt Drives – Pulleys and V-Ribbed belts for Industrial applications – PH, PJ, PK, Pl and PM Profiles : Dimensions
- IS 2122 : Part 1: 1973, Code of practice for selection, storage, installation and maintenance of belting for power transmission : Part 1 Flat Belt Drives.IS 2122: Part 2: 1991, Code of practice for selection, storage, installation and maintenance of belting for power transmission: Part 2 V-Belt Drives

E RESOURCES

1. http://nptel.iitm.ac.in/courses
2. http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	1	-	2	1	2	1	2	3	2	
CO2	3	2	3	-	1	-	2	1	2	1	2	3	2	
CO3	3	2	3	-	1	-	2	1	2	1	2	3	2	
CO4	3	2	3	-	1	-	2	1	2	1	2	3	2	
CO5	3	2	3	-	1	-	2	1	2	1	2	3	2	
TOT	**15**	**10**	**15**	**0**	**5**	**0**	**10**	**5**	**10**	**5**	**10**	**15**	**10**	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK – II**	
Subject Name	**Mechanical Vibrations**	
Subject Code	**XMEE09**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	*Define* vibration and *Classify* different types of vibrations also *Model* different types of vibrations on mechanical systems	C(Remember, Understand , Apply)
CO2	*Classify* different degrees of freedom systems *Model* different degrees of freedom systems also *solve* for different types of motion	C(Understand , Apply)
CO3	*Define* motion and *Classify* different types of motion also *Model* different types of equations of motion *solve* different types of equations of motion	C(Remember, Understand , Apply)

CO4	*Define* Transient vibration and continuous systems and *Classify* different types of excitation also *Model* different types of vibration based on laplace transformation also continuous system *solve* using different types of governing equation	C(Remember, Understand , Apply
CO5	*Measure* Vibration *Classify* different types of exciters and analyzers also *Explain* different aspects of vibration control *solve* different vibration control problems	C(Evaluate, Understand , Apply)

COURSE CONTENT

UNIT I	**FUNDAMENTALS OF VIBRATION**	**9 hrs**

Introduction - Vibration in rigid body dynamics - need for analysis. Mathematical modeling of vibrating systems - discrete and continuous systems – free and forced vibrations – periodic and non-periodic forcing functions - dynamics of rotating and reciprocating engines.

UNIT II	**SINGLE DEGREE AND TWO DEGREES OF FREEDOM SYSTEMS**	**9 hrs**

Single degree of freedom systems - various damping models - decay plots and half power method – critical speed for industrial rotor.

Two degrees of freedom systems - Generalized and principal co-ordinates, Equations of motion - Lagrange's equation - Application to undamped and damped absorbers - Torsional system – Spring coupled system – mass coupled system.

UNIT III	**MULTI DEGREES OF FREEDOM SYSTEMS**	**9 hrs**

Equations of motion - influence coefficients - orthogonality principle – Natural frequency calculations by Rayleigh's, Dunkerley's and Holzer's methods.

UNIT IV	**TRANSIENT VIBRATION AND CONTINUOUS SYSTEMS**	**9 hrs**

Impulse and arbitrary excitation - base excitation - Laplace transform formulation - response spectrum - impulse, transient and forced vibration response of single degree of freedom system.

Continuous systems - governing wave equation and Euler-Bernoulli equation. Modal analysis of free and forced vibrations.

UNIT V	**VIBRATION MEASUREMENT AND CONTROL**	**9 hrs**

Measurement of vibration - vibration measuring instruments - mechanical exciters, electrical exciters and transducers – frequency analyzers, vibration analyzers - impact hammer.

Methods of vibration control - excitation reduction at source, balancing of rigid, flexible and variable mass rotors. Dynamic properties and selection of structural materials - vibration absorbers - vibration isolation.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Thomson W T, "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
2. Ambekar A.G., “Mechanical Vibrations and Noise Engineering”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2006

REFERENCES

1. Rao S S, "Mechanical Vibrations", Addison Wesley, USA, 1995.
2. Thomson W T, "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
3. Seto, “Mechanical Vibrations ", Schaum Outline Series, McGraw Hill Inc., New York, 1990.
4. Grover G K, "Mechanical Vibrations ", New Chand and Brothers, Roorkey, 1989.

E RESOURCES

1. http://nptel.iitm.ac.in/courses
2. http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO2	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO3	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO4	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO5	3	3	2	3	3	1	3	1	1	2	2	3	2	
TOT	15	15	10	15	15	5	15	5	5	10	10	15	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-II**
Subject Name	**Computational Fluid Dynamics**
Subject Code	**XMEE10**

L –T –P –C	C:P:A	L –T –P –H
3- 0 – 0– 3	3:0:0	3- 0– 0– 3

Course Outcome		Domain/Level C or P or A
CO1	***Define and apply*** governing equations of fluid dynamics ***Explain and apply*** turbulence kinetic energy equations, mathematical behavior of PDE on CFD	C(Remember, Understand , Apply)
CO2	***Define*** methods of deriving the discretization equations ***Explain and apply*** different methodologies for deriving solution	C(Understand , Apply)
CO3	***Define and explain*** steady / transient one dimensional conduction equation. A***pply*** finite volume formulation for conduction problems.	C(Remember, Understand , Apply)
CO4	**Explain and Solve** steady one dimensional conduction and diffusion problems	C(Remember, Understand , Apply
CO5	**Solve** fluid flow field calculations using CFD models	C(Remember, Understand , Apply

COURSE CONTENT

UNIT I	**GOVERNING EQUATIONS AND BOUNDARY CONDITIONS**	**9 hrs**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent flow - Turbulence -Kinetic -Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

UNIT II	**DISCRETIZATION AND SOLUTION METHODOLOGIES**	**9 hrs**

Methods of Deriving the Discretization Equations - Taylor Series formulation – Finite difference method – Control volume Formulation – Spectral method.

Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

UNIT III	**HEAT CONDUCTION**	**9 hrs**

Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

UNIT IV	**CONVECTION AND DIFFUSION**	**9 hrs**

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.

UNIT V	**CALCULATION OF FLOW FIELD**	**9 hrs**

Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE algorithm and its variants. Turbulence models: mixing length model, Two equation (k-e) models.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman, 1998.

2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw-Hill Publishing Company Ltd., 1998.

REFERENCES

1. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", McGraw-Hill, 1980. Ane-Books2004 Indian Edition.

2. Muralidhar, K and Sundarajan .T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.3. Bose, T.K., "Numerical Fluid Dynamics", Narosa publishing House, 1997.

4. Muralidhar, K and Biswas "Advanced Engineering Fluid Mechanics", Narosa Publishing House, New Delhi, 1996.

5. Anderson, J.D., "Computational fluid dynamics – the basics with applications", 1995.

E RESOURCES

http://nptel.iitm.ac.in

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	3	-	1	-	-	2	2	3	2	
CO2	3	1	-	2	3	-	1	-	-	2	2	3	2	
CO3	3	-	-	1	2	-	1	-	-	1	-	2	2	
CO4	2	-	-	1	2	-	1	-	-	1	-	1	2	
CO5	3	2	-	2	3	-	1	-	-	1	2	2	2	
TOT	14	4	-	6	13	-	5	-	-	7	6	11	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-II**
Subject Name	**Machine Drawing**

Subject Code	XMEE11	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	To Understand the codes and practices.	C(Remember, Understand , Apply)
CO2	To apply tolerances and fits in the drawings.	C(Understand , Apply)
CO3	To remember the symbols of machine drawing	C(Remember, Understand , Apply)
CO4	To understand the working fasters like cotter joint, knuckle joint, etc.,	C(Remember, Understand , Apply
CO5	To understand the working components	C(Remember, Understand , Apply

COURSE CONTENT

UNIT I CODES AND PRACTICES 9 hrs

Indian standard code of practice for engineering drawing –general principles of presentation, conventional representations of threaded parts, springs, gear and common features. Abbreviations and symbols for use in technical drawings, Conventions for sectioning and dimensioning.

UNIT II TOLERANCES 9 hrs

Tolerances –types –representation of tolerances on drawings, Geometric tolerance –form and positional tolerances –datum, datum features, fits –types –selection of fits –allowances

UNIT III DRAWING SYMBOLS 9 hrs

Maximum material principal-symbols and methods of indicating it on drawing –surface finish symbols –welding symbols and methods of indicating them on drawings

UNIT IV WORKING DRAWINGS OF FASTENERS 9 hrs

Preparation of working drawing for the Fasteners like:
Nuts, bolts –screws, keys and keyways, joints –cotterjoint and knuckle joint.

UNIT V WORKING DRAWINGS OF MACHINE COMPONENTS 9 hrs

Preparation of working drawings for the machine components like:
Connecting rod, Plummer block, screw jack, cross head for horizontal and vertical engines, swivel bearing, machine vice, lathe tail stock, toolhead of a shaper, stop valve,

safety valve, pressure relief valve.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Machine drawing by Gopalakrishnan, Subash Publishers,2002

REFERENCES

1. Machine drawing , N.D. Bhatt, Charotar Publishing House, Anand

2. Machine drawing, N.Siddeswar, P.Kanniah, and V.V.S. Satry TataMcGraw Hill, 1980
3. Revised IS codes:

10711,10713,10714,9609,1165,10712,10715,10716,10717,11663,11668, 10968,11669,8043,8000

E RESOURCES

http://nptel.iitm.ac.in

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	3	1	1	2	3	3	2	
CO2	3	3	3	1	3	1	3	1	1	1	2	3	2	
CO3	3	3	3	1	3	1	3	1	1	1	2	3	2	
CO4	3	3	3	1	3	1	3	1	1	1	2	3	2	
CO5	3	3	3	1	3	1	3	1	1	1	2	3	2	
TOT	15	15	15	6	15	6	15	5	5	6	11	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**TRACK-II**
Subject Name	**Design of Jigs and Fixtures and Press tools**
Subject Code	**XMEE12**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand the locating and clamping principles.	C(Remember, Understand , Apply)
CO2	Study about jigs and fixtures and its principles.	C(Understand , Apply)

CO3	Understand about press working terminologies and elements.	C(Remember, Understand , Apply)
CO4	Classify and understand bending and drawing dies.	C(Remember, Understand , Apply
CO5	Understand various forming techniques.	C(Remember, Understand , Apply

COURSE CONTENT

UNIT I	**Locating and clamping principles**	**8 hrs**

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II	**Jigs and Fixtures**	**10 hrs**

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III	**PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES**	**10 hrs**

Press Working Terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV	**BENDING AND DRAWING DIES**	**10 hrs**

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V	**Other Forming Techniques**	**7 hrs**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction – tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

L = 45 hrs Total = 45 hr

TEXT BOOKS

- Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
- Joshi P.H “Press tools – Design and Construction”, wheels publishing, 1996

REFERENCES

- Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.
- Donaldson, Lecain and Goold “Tool Design”, 3rd Edition, Tata McGraw Hill, 2000.
- Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.
- Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
- ASTME Fundamentals of Tool Design Prentice Hall of India.
- Design Data Hand Book, PSG College of Technology, Coimbatore.

E RESOURCES

http://nptel.iitm.ac.in

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	2	1	2	3	3	2	
CO2	3	3	2	3	3	1	3	2	1	2	3	3	2	
CO3	3	3	2	3	3	1	3	2	1	2	2	3	2	
CO4	3	3	2	3	3	1	3	2	1	2	2	3	2	
CO5	3	3	2	3	3	1	3	2	1	2	2	3	2	
TOT	15	15	10	15	15	5	15	10	5	10	12	15	10	

1 - Low, 2 – Medium, 3- High

Semester TRACK-II

Subject Name	**Mathematical Modelling and Simulation**	
Subject Code	**XMEE13**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	*Define* system and *Classify* different aspects of systems also *Model* different types of mechanical systems	C(Remember, Understand , Apply)
CO2	*Define* random number *Model* different degrees of freedom systems also *compile* code for different types of random numbers	C(Understand , Apply)
CO3	*Explain* Problem simulation using different methods and *Classify* different types of simulation tools *Model* systems using different representational tools *solve* for typical simulation problem	C(Remember, Understand , Apply)
CO4	*Classify* different types of simulation languages available also able to *select* suitable simulation languages for different simulation problem also *demonstrate* expertise on any one simulation language	C(Remember, Understand , Apply
CO5	*Interpret* development of simulation models *Classify* simulation models *Explain* different types of systems *develop* simulation code for real-time problem *solve* the problem using simulation tools	C(Remember, Understand , Apply

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**

Systems, modeling, general systems theory, concept of simulation, simulation as a decision making tool, types of simulation.

UNIT II	**RANDOM NUMBERS AND VARIATES**	**9 hrs**

Pseudo random numbers, methods of generating random variates, testing of random numbers and variants.

UNIT III	**DESIGN OF SIMULATION EXPERIMENTS**	**9 hrs**

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation validation.

UNIT IV	**SIMULATION LANGUAGES**	**9 hrs**

Comparison and selection of simulation languages, study of any one simulation language.

UNIT V	**CASE STUDIES / MINI PROJECT**	**9 hrs**

Development of simulation models using the simulation language studied for systems

like, queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network.

L = 45 hrs Total = 45 hr

TEXT BOOKS AND REFERENCES

1.Jerry Banks and John S.Carson, Barry L Nelson, David M.Nicol, P.Shahabudeen,
2.Discrete event system simulation, Pearson Education, 2007.
3.Law A.M, Simulation Modelling and Analysis, Tata Mc Graw Hill,2008
4.Thomas J.Schriber, Simulation using GPSS, John Wiley, 1991.
Kelton, W. David, Simulation with Arena ,McGraw-Hill,2006

E RESOURCES

1. http://www.intechopen.com
2. https://www.scilab.org/resources/documentation/tutorials

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1		2	1			2	2	2	
CO2	2	2	2		1		2	1			2	2	2	
CO3	2	2	2		1		2	1			2	2	2	
CO4	2	2	2	1	1		2	1			2	2	2	
CO5	2	2	2	1	1	1	2	1			2	2	2	
	10	10	10	3	5	1	10	5			10	10	10	

1 - Low, 2 – Medium, 3- High

Semester	**TRACK-II**	
Subject Name	**Computer Aided Design**	
Subject Code	**XMEE14**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0–3**

Course Outcome		**Domain/Level C or P or A**
CO1	Apply fundamentals of computer graphics and relate 2D and 3D transformations.	C (Apply)

CO2	Summarize Mathematical Representation for curves and surfaces	C (Understand)
CO3	Make use of concepts of visual realism and computer animation	C (Apply)
CO4	Build the model by understanding the concept of ASSEMBLY	C (Analyse)
CO5	Interpret relevant CAD Standards	C (understand)

COURSE CONTENT

UNIT I	**FUNDAMENTALS OF COMPUTER GRAPHICS**	**9 hrs**

Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation

UNIT II	**GEOMETRIC MODELING**	**9hrs**

Representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep.

UNIT III	**VISUAL REALISM**	**9 hrs**

Hidden line-surface-solid removal algorithms, shading, colouring, computer animation

UNIT IV	**ASSEMBLY OF PARTS**	**9hrs**

Assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking

UNIT V	**CAD STANDARDS**	**9hrs**

Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

L = 45 hrs T = 0 hrs P=0hrs Total =45 hrs

TEXT BOOKS

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.

2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.

3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.

4. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992.

REFERENCES

- Chris McMahon and Jimmie Browne “CAD/CAM Principles”, “Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.
- William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.
- Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1992.
- Foley, Wan Dam, Feiner and Hughes – “Computer graphics principles & practice” Pearson

Education – 2003.

E-REFERENCES

http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	2	1	2	2	3	2	
CO2	3	2	3	2	1	3	2	2	2	1	2	2	2	
CO3	3	3	3	2	3	1	2	3	3	2	2	3	2	
CO4	3	3	3	2	3	3	2	2	2	3	2	3	2	
CO5	3	2	3	2	3	2	2	3	3	2	2	2	2	
TOT	15	13	15	10	12	11	11	12	11	10	10	13	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**
Subject Name	**Unconventional Manufacturing Technology**
Subject Code	**XMEE15**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Explain** the principles of material removal mechanism of advanced machining processes such as mechanical, electro-chemical.	C(Remember, Understand , Apply)
CO2	**Classify** the mechanism of Mechanical machining processes, economic considerations in Ultrasonic machining	C(Understand , Apply)
CO3	**Determine** Thermal Metal Removal Processes, characteristics of spark eroded surface, machine tool selection.	C(Remember, Understand , Apply)
CO4	**Interpret** Electro Chemical machining process, economic aspects of ECM and problems on estimation.	C(Remember, Understand , Apply
CO5	**Relate** Generation and control of electron beam for machining, laser beam machining and comparison	C(Remember, Understand , Apply)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**6 hrs**

Unconventional machining Process – Need – classification – Brief overview.

UNIT II	**MECHANICAL ENERGY BASED PROCESSES**	**9 hrs**

Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining.(AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT III	**ELECTRICAL ENERGY BASED PROCESSES**	**9 hrs**

Electric Discharge Machining (EDM)- working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

UNIT IV	**CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES**	**11 hrs**

Chemical machining and Electro-Chemical machining (CHM and ECM)-Etchants – Maskant – techniques of applying maskants – Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process Parameters-ECG and ECH – Applications.

UNIT V	**THERMAL ENERGY BASED PROCESSES**	**10 hrs**

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types – Beam control techniques – Applications.

L = 45 hrs Total = 45 hr

TEXT BOOKS AND REFERENCES

1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 2007
2. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi, 2007.
3. Benedict. G.F. “Nontraditional Manufacturing Processes”, Marcel Dekker Inc., New York, 1987.

4. Mc Geough, “Advanced Methods of Machining”, Chapman and Hall, London, 1998

5. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, “Material and Processes in Manufacturing” Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

E RESOURCES

1. http://www.intechopen.com
2. https://www.scilab.org/resources/documentation/tutorials

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	2	2	1	3	3	3	
CO2	3	3	1	2	1	1	1	2	1	1	3	2	3	
CO3	3	3	2	1	2	1	2	2	1	1	3	3	3	
CO4	3	3	2	2	1	2	2	2	1	2	2	3	3	
CO5	2	3	2	2	2	1	2	2	1	3	3	2	3	
	14	15	10	9	8	7	10	10	6	8	14	13	15	

1 - Low, 2 – Medium, 3- High

Semester	**TRACK-III**
Subject Name	**Microelectromechanical Systems**
Subject Code	**XMEE16**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0–3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Identify** working principles of currently available micro sensors, actuators.	C (Apply)
CO2	**Compare** the positive and negative consequences of scaling down certain physical quantities that are pertinent to micro systems	C (Understand)
CO3	**List** materials for common micro components and devices.	C (Apply)
CO4	**Choose** a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process	C (Analyse)
CO5	**Select** the suitable MEMS packaging	C (understand)

COURSE CONTENT

UNIT I	**MEMS COMPONENTS AND MATERIALS**	**9 hrs**

Introduction to microelectromechanical systems and technologies – Microsystems and microelectronics interface. MEMS components - working principle and applications – microsensors, micro actuators, microaccelerometers. Materials for MEMS - Substrates and wafers - Desirable properties - mechanical, thermal, electrical, magnetic, optical, and chemical properties – Silicon, Silicon compounds, Gallium arsenside, Quartz-

piezoelectric crystals and conductive polymers.

UNIT II	DESIGN OF MEMS	9hrs

Scaling laws in miniaturization - Scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, fluid flow and heat transfer. Basic modeling elements - Introduction to lumped modeling of systems and transducers; an overview of system dynamics – modeling dissipative processes – fluids and transport phenomenon -Design of mechanical sensors for displacement, pressure and flow.

UNIT III	MEMS DEVICES	9 hrs

Mechanical sensors and actuators – Principles of strain measurement, pressure measurement, flow measurement and MEMS gyroscope. Thermal sensors and actuators – Principles of thermal flow sensors, microhotplate gas sensors, micromachined thermocouple probe and MEMS thermovessels. Introduction to RF MEMS, MOEMS, BIOMEMS and microfluidic systems.

UNIT IV	MICROMANUFACTURING TECHNIQUES	9hrs

Microfabrication for MEMS –Photolithography - photoresists and light sources. Chemical vapour deposition – Physical vapour deposition – Ion implantation – Sputtering – Epitaxial growth – Molecular beam epitaxy. Bulk micromachining and surface micromachining – principles. Etching - isotropic and anisotropic etching - wet and dry etching – Deep reactive ion etching – etchants and etch stops. LIGA and electroplating processes.

UNIT V	MEMS PACKAGING	9hrs

MEMS packaging - general factors and considerations - selection of packaging materials. Levels of packaging – die level, device level and system level. Essential packaging technologies – die preparation – surface bonding, wire bonding and sealing. Three dimensional packaging - issues. Assembly of MEMS

L = 45 hrs T = 0 hrs P=0hrs Total =45 hrs

TEXT BOOKS

1. Tai-Ran Hsu,“MEMS and Microsystems Design and Manufacture“, Tata McGraw Hill Publishing Co.Ltd.,New Delhi, 2007
2. Mahalik N.P., “MEMS”, Tata McGraw Hill Publishing Co.Ltd.,New Delhi, 2007.

REFERENCES

1. Mark Madou “Fundamentals of Microfabrication”, CRC Press, New York, 1997.
2. Chang C Y and Sze S M, “VLSI Technology”, Mc Graw Hill, New York, 2000.
3. Sami Franssila , “Introduction to Microfabrication”, John Wiley; 1st edition, 2004.
4. Marc J. Madou, “Fundamentals of Microfabrication, the science of Miniaturization”, CRC Press Second Edition, 2002

E-REFERENCES

1. http://nptel.iitm.ac.in/courses
2. http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO2	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO3	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO4	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO5	2	1	2	1	1	2	2	1	1	1	2	1	3	
	6	5	10	5	5	10	6	5	5	5	6	5	15	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**	
Subject Name	**Industrial Safety**	
Subject Code	**XMEE17**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0–3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Evaluate** the safety performance of an organization from accident records	C (Apply)
CO2	**Explain** the functions and activities of safety engineering department	C (Understand)
CO3	**Select** complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment	C (Apply)
CO4	**Choose** the various physiological functions of our body and the test methods for periodical monitoring of health	C (Analyse)

CO5	**List** out important legislations related to Health , Safety and Environment	C (understand)

COURSE CONTENT

UNIT I	**ACCIDENT PREVENTION**	**9 hrs**

Definitions - history of safety movement - ILO – NSC – BSC – LPA - theories and principles of accident causation - cost of accidents - accident reporting and investigation - safety committee - safety suggestion scheme - safety education and training -safety management techniques

UNIT II	**SAFETY MANAGEMENT**	**9hrs**

Safety systems - safety information system – safety control system - hazard and risk analysis – risk assessment methodologies - Fault Tree Analysis (FTA) and Event Tree Analysis (ETA) - total loss control - risk management.

UNIT III	**HUMAN FACTORS ENGINEERING**	**9 hrs**

Man machine system- human behaviour- principles of ergonomics- factors impeding safety and personal protective equipment.

UNIT IV	**OCCUPATIONAL HEALTH AND HYGIENE**	**9hrs**

Physical hazards - chemical hazards – recognition of hazards – evaluation – control measures - occupational health – concept and spectrum of health – industrial toxicology – definitions – hazard – toxicity – local and systemic effect – routes of entry

UNIT V	**SAFETY REGULATION**	**9hrs**

History of legislations related to safety - factories act and rules - workmen compensation act - OSHA standards.

L = 45 hrs T = 0 hrs P=0hrs Total =45 hrs

TEXT BOOKS

1. John V Grimaldi and Rollin H Simonds, Safety management, All India Travelers book seller, New delhi,1989. 2. Occupational Safety manual, BHEL, 2002.

REFERENCES

1. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.

2. Brown, D.B., System Analysis and Design for Safety, Prentice Hall Inc., New Jersy, 1976.

3. Encyclopedia of Occupational Health and Safety, Vol. I and II, International Labour Organisation, Geneva, 1985.

4. Handbook of Occupational Health and Safety, NSC Chicago, 1982.

5. Heinrich, H.W., Industrial Accident Prevention, McGraw-Hill, 1980.

6. Lees, F.P., Loss Prevention in Process Industries, Butterworths, New Delhi, 1986.

7. McCornick, E.J., and Sanders, M.S., Human Factors in Engineering and Design, Tata McGraw-Hill,

1982.

E-REFERENCES

http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO2	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO3	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO4	1	1	2	1	1	2	1	1	1	1	1	1	3	
CO5	2	1	2	1	1	2	2	1	1	1	2	1	3	
	6	5	10	5	5	10	6	5	5	5	6	5	15	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**
Subject Name	**Industrial Robotics**
Subject Code	**XMEE18**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0–3**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand about robot configurations and drives.	C(Understand)
CO2	Classify various components and operations of robots.	C(Remember)
CO3	Understanding about sensors and machine vision systems.	C(Understand)
CO4	Analyze the robot programming	C(Analyze)
CO5	Apply the robots in different fields.	C(Apply)

COURSE CONTENT

UNIT I INTRODUCTION **9 hrs**

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drives -

Basic robot motions - Point to point control - Continuous path control.

UNIT II COMPONENTS AND OPERATIONS 9hrs

Basic control system concepts - control system analysis - robot actuation and fed back, Manipulators - director and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors - Grippers - Tools as end effectors - Robot/End - effort interface.

UNIT III SENSING AND MACHINE VISION 9 hrs

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

UNIT IV ROBOT PROGRAMMING 9hrs

Methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation - Search techniques - A1 and Robotics.

UNIT V INDUSTRIAL APPLICATIONS 9hrs

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.

L = 45 hrs T = 0 hrs P=0hrs Total =45 hrs

TEXT BOOKS

K.S. Fu., R.C.Gonalez, C.S.G.Lee, " Robotics Control sensing ", Vision and Intelligence, McGraw Hill International Edition, 1987.

REFERENCES

1. Mikell P. Groover, mitchell Weiss, " Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 1986.
2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, " Robotic engineering - An Integrated Approach ", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

E-REFERENCES

http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	**2**	-	**1**	**1**	-	-	-	-	**1**	**3**	
CO2	-	-	-	**2**	-	**1**	**2**	-	-	-	**1**	**1**	**3**	
CO3	-	**2**	-	**1**	**2**	-	**1**	-	**2**	**1**	**2**	**1**	**3**	
CO4	-	**1**	-	**1**	**1**	-	**1**	-	**1**	-	**1**	**1**	**3**	

CO5	-	-	-	2	-	1	1	-	1	1	1	1	3	
Total	-	3	-	8	3	3	6	-	4	2	5	5	15	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**
Subject Name	**Total Quality Management**
Subject Code	**XMEE19**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***List*** and ***Explain*** the basic concepts of total quality concepts and its limitations.	Cognitive (Remembering) (Understanding)
CO2	***Analyze*** and ***Explain*** the Customer satisfaction, Employee involvement, supplier selection and appraise the performance by TQM principle.	Cognitive (Analyzing) (Evaluating)
CO3	***Select*** and ***Explain*** the different TQM tools and their significance.	Cognitive (Remembering) (Understanding)
CO4	***Explain*** and ***Apply*** the Statistical Process Control Tools.	Cognitive (Understanding) (Applying)
CO5	***Explain*** the importance aspects of different quality systems.	Cognitive (Understanding)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

UNIT II	**TQM PRINCIPLES**	**9 hrs**

TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

UNIT III	TQM TOOLS	9 hrs

The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

UNIT IV	STATISTICAL PROCESS CONTROL (SPC)	9 hrs

TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

UNIT V	QUALITY SYSTEMS	9 hrs

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation,; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

L = 45 hrs T = 0 hrs P=0 hrs Total = 45 hrs

TEXT BOOKS

1. Besterfield D.H. et al., Total qualityManagement, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

REFERENCES

1. Feigenbaum, A.V., "Total Quality Management", McGraw Hill, 1991.

2. Oakland, J.S., "Total Quality Management", Butterworth Heineman, 1989.

3. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks",

   New Age International, 1996.

4. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

E-REFERENCES

1. http://nptel.ac.in/faq/110101010/Prof.IndrajitMukherjee,IIT,Bombay and Prof. Tapan P.Bagchi, IIT, Kharagpur.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	1	-	-	3	-	2	-	2	3	3	2	
CO2	2	3	3	2	3	2	-	3	2	2	3	3	2	
CO3	3	3	3	3	3	3	1	2	1	2	2	2	2	

CO4	3	2	3	3	3	3	-	2	2	2	3	3	2	
CO5	-	2	2	-	-	1	-	1	1	2	-	-	2	
	10	**10**	**12**	**8**	**9**	**12**	**1**	**10**	**6**	**10**	**11**	**11**	**10**	

1 - Low, 2 – Medium, 3- High

Semester	**TRACK-III**
Subject Name	**PRODUCT DESIGN AND DEVELOPMENT**
Subject Code	**XMEE20**

L –T –P –C	**C:P:A**	**L –T –P –H**
3-0–0–3	**3:0:0**	**3- 0– 0 –3**

Course Outcome		**Domain/Level C or P or A**
CO1	Classify the processes involved in product development and different techniques.	C(Understanding)
CO2	Find the various product specifications and principles needed for the product development process.	C(Remembering)
CO3	List the various product development concepts and issues.	C(Remembering)
CO4	Recall the industrial design process and DFM and also about other design principles.	C(Remembering)
CO5	Define the various techniques involved in the prototyping process.	C(Remembering)

COURSE CONTENT

UNIT I	**PRODUCT DEVELOPMENT**	**9 hrs**

Product Development process – Product development organizations - Raw data manipulation – Gathering, interpretation and organizing hierarchically based on needs. Human factors, ergonomics and other factors - product development versus design. Product cost analysis and cost models - Reverse engineering and redesign product development process - New product development.

UNIT II	**PRODUCT FUNCTIONAL REQUIREMENT**	**9 hrs**

Establishing the product specifications – Target specifications – Refining specification. Principles of design - axiomatic approach, functional decomposition, mathematical representation, and functional analysis – examples.

UNIT III	**PRODUCT CONCEPTS**	**9 hrs**

Concept generation, evaluation and selection. Product architecture – Implication and establishing - Related system level design issues. Quality function deployment, product

design specification

UNIT IV INDUSTRIAL DESIGN 9 hrs

Introduction – need and impact of industrial design – Industrial design process and its management – Assessing the quality of industrial design - design for manufacturing - cost considerations, Impact of DFM decisions on other factors. Reliability, failure identification techniques, design for maintainability, product safety and packaging.

UNIT V PROTOTYPING 9 hrs

Principles of prototyping – Types and techniques - Planning for prototypes, economics of product development projects, Elements of economic analysis – Financial model – Sensitivity analysis – Influence of the quantitative factors – softwares in prototyping, 3D Printing and Rapid Prototyping.

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9

2. Kevin Otto, Kristin Wood, "Product Design techniques in Reverse Engineering and New Product Development", 1rd Edition, 2006, PEARSON Publishing Ltd. ISBN-978-81-7758-821-7.

REFERENCES

1.S.Rosenthal, Effective Product Design and Development, Irwin, 1992.

2. Charles Gevirtz Developing New products with TQM, McGraw Hill International

Editions, 1994.

3.Harry Nystrom, " Creativity and innovation", John Wiley & Sons, 1979.

4. Frank W. Liou, Rapid Prototyping & engineering applications, CRC Press, 2008.3. Stoecker N.F and Jones, "Refrigeration and Air Conditioning", TMH, New Delhi, 1981.

E-REFERENCES

1. http://nptel.iitm.ac.in.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	2	3	1	2	2	1	2	2	3	2	2	
CO2	1	-	1	2	2	2	2	1	1	2	2	2	2	
CO3	1	-	1	2	1	1	2	1	1	2	2	2	2	
CO4	1	-	1	2	1	1	3	1	1	3	3	3	2	
CO5	2	2	1	2	1	1	3	1	1	3	3	3	2	

	6	2	6	11	6	7	12	5	6	12	13	12	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**
Subject Name	**Computer Integrated Manufacturing**
Subject Code	**XMEE21**

L –T –P –C	**C:P:A**	**L –T –P –H**
3-0– 0–3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Define** the manufacturing activities interrelated with computers for plant operations.	C (Remembering)
CO2	**Understand** the concept of Group Technology and the various approaches of Computer Aided Process Planning.	C (Understanding)
CO3	**Organize** the shop floor control	C (Applying)
CO4	**Compare** the system modeling tools in CIM and the fundamental concepts of data communications.	C (Evaluating)
CO5	**Discuss** the applications of database and system protocol	C (Creating)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**8 hrs**

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - islands of automation and software-dedicated and open systems-manufacturing automation protocol - product related activities of a company-marketing engineering - production planning - plant operations - physical distribution-business and financial management.

UNIT II	**GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING**	**10 hrs**

History of group technology- role of G.T. in CAD/CAM integration - part families - classification and coding - DCLASS and MICLASS and OPITZ coding systems-facility design using G.T. -benefits of G.T. – Lean and cellular manufacturing.

Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning -variant approach and generative approaches - CAPP and CMPP process planning systems.

UNIT III	SHOP FLOOR CONTROL AND INTRODUCTION OF FMS	9 hrs

Shop floor control-phases - factory data collection system - automatic identification methods- Bar code technology-automated data collection system.

FMS-components of FMS - types - FMS workstation -material handling and storage systems- FMS layout -computer control systems-application and benefits.

UNIT IV	CIM IMPLEMENTATION AND DATA COMMUNICATION	9 hrs

CIM and company strategy - system modeling tools -IDEF models - activity cycle diagram - CIM open system architecture (CIMOSA)- manufacturing enterprise wheel-CIM architecture - Product data management-CIM implementation software.

Communication fundamentals- local area networks -topology - LAN implementations - network management and installations.

UNIT V	OPEN SYSTEM AND DATABASE FOR CIM	9 hrs

Open systems-open system inter connection - manufacturing automations protocol and technical office protocol (MAP /TOP)

Development of databases -database terminology- architecture of database systems-data modeling and data associations -relational data bases - database operators - advantages of data base and relational database.

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

1.Mikell.P.Groover,"Automation,Production Systems and computer integrated manufacturing", Pearson Education,2007.

2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM",New Age International (P) Ltd, New Delhi,. 2004.

REFERENCES

1. Yorem koren,"Computer Integrated Manufacturing system", McGraw-Hill, 2002.

2. Ranky, Paul G.,"Computer Integrated Manufacturing", Prentice Hall International, 2003.

3. David D.Bedworth, Mark R.Hendersan, Phillip M.Wolfe "Computer Integrated Design and Manufacturing", McGraw-Hill Inc, 2004.

4. Roger Hanman "Computer Intergrated Manufacturing", Addison –Wesley, 2007.

5. Mikell.P.Groover and Emory Zimmers Jr.,"CAD/CAM", Prentice hall of India Pvt. Ltd., New Delhi, 2003.

6. Kant Vajpayee S, "Principles of computer integrated manufacturing", Prentice Hall India, 2007.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses
2. http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	2	3	1	2	2	1	2	2	3	2	3	
CO2	1	-	1	2	2	2	2	1	1	2	2	2	3	
CO3	1	-	1	2	1	1	2	1	1	2	2	2	3	
CO4	1	-	1	2	1	1	3	1	1	3	3	3	3	
CO5	2	2	1	2	1	1	3	1	1	3	3	3	3	
	6	2	6	11	6	7	12	5	6	12	13	12	15	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**
Subject Name	**Process Planning and Cost Estimation**
Subject Code	**XMEE22**

L –T –P –C	**C:P:A**	**L –T –P –H**
3-0– 0–3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand about material selection and Process planning and its factors , parameters	C (Remembering)
CO2	Classify about various activities involved in Process planning	C (Understanding)
CO3	Remember about various cost estimation	C (Applying)
CO4	Analyze various costs, allowances and machining time for various operations.	C (Evaluating)
CO5	Classify and Analyze various costs	C (Creating)

COURSE CONTENT

UNIT I	**Introduction**	**8 hrs**
	Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection	
UNIT II	**Process planning**	**10 hrs**

Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies

UNIT III **Cost estimation** **9 hrs**

Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of laor cost, material cost, allocation of overhead charges, calculation of depreciation cost

UNIT IV **Machining time calculations and allowances** **9 hrs**

Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planning and Grinding

UNIT V **Estimation of Various costs** **9 hrs**

Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

1. Peter Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sci.&Tech. 2002.
2. Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th ed., John Wiley 1998.
3. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 2nd ed., Prentice Hall 2002.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	2	3	1	2	2	1	2	2	3	2	2	
CO2	1	-	1	2	2	2	2	1	1	2	2	2	2	
CO3	1	-	1	2	1	1	2	1	1	2	2	2	2	
CO4	1	-	1	2	1	1	3	1	1	3	3	3	2	
CO5	2	2	1	2	1	1	3	1	1	3	3	3	2	
	6	2	6	11	6	7	12	5	6	12	13	12	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**
Subject Name	**Composite Materials**
Subject Code	**XMEE23**

L –T –P –C	**C:P:A**	**L –T –P –H**
3-0– 0–3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand the mechanical behaviour of Composite materials	C (Remembering)
CO2	Understand the characteristics of composite materials	C (Understanding)
CO3	Classify and Analyze various manufacturing methods of composite materials.	C (Applying)
CO4	Remember various assumptions of composite materials.	C (Evaluating)
CO5	Analyze the composite materials.	C (Creating)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**6 hrs**
	Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibers; Matrices-polymer, graphite, ceramic and metal matrices;	
UNIT II	**CHARACTERISTICS AND PROPERTIES**	**9 hrs**
	Characteristics of fibers and matrices. Lamina-assumptions, macroscopic viewpoint, generalized Hookes law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.	
UNIT III	**MANUFACTURING OF COMPOSITE MATERIALS**	**6 hrs**
	Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes	
UNIT IV	**ASSUMPTIONS OF COMPOSITE MATERIALS**	**12 hrs**
	Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates	
UNIT V	**ANALYSIS OF COMPOSITE MATERIALS**	**12 hrs**
	Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies	

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses
2. http://www.intechopen.com/books

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	2	2	2	2	1	1	1	2	
CO2	3	2	2	2	1	2	1	2	1	1	1	2	2	
CO3	3	2	2	2	1	1	2	1	2	1	1	2	2	
CO4	3	2	2	2	2	1	2	2	2	1	2	2	2	
CO5	3	3	2	3	3	1	2	2	2	1	2	3	2	
	15	12	11	12	8	7	9	9	9	5	7	10	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**	
Subject Name	**AUTOMOTIVE ELECTRONICS**	
Subject Code	**XMEE24**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3-0– 0–3	**3:0:0**	**3- 0– 0 –3**

Course Outcome		**Domain/Level** **C or P or A**
CO1	Classify the lighting system and accessories.	C(Understanding, Analyzing)
CO2	Define the starter and its maintenances	C(Remembering)

CO3	Identify and interpret charging system	C(Applying)
CO4	Analyze the concepts of automotive electronic engine management system, dashboard and warning systems	C(Analyzing)
CO5	Compare the working principle of various sensors	C(Understanding, Evaluating)

COURSE CONTENT

UNIT I	**BATTERIES AND ACCESSORIES**	**13 hrs**

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods – Horn, wiper system and trafficator

UNIT II	**STARTING SYSTEM**	**9 hrs**

Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches

UNIT III	**CHARGING SYSTEM**	**7 hrs**

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout. Voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects and bridge rectifiers, new developments.

UNIT IV	**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**	**8 hrs**

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system

UNIT V	**SENSORS AND ACTIVATORS**	**8 hrs**

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

1.Young A.P. & Griffiths. L. “Automotive Electrical Equipment”, ELBS & New Press, 1999.

2.William B.Riddens “Understanding Automotive Electronics”, Fifth Edition, Butter worth Heinemann Woburn, 1998.

REFERENCES

- Bechhold “Understanding Automotive Electronics”, SAE, 1998.
- Crouse, W.H “Automobile Electrical Equipment”, Third Edition, McGraw-Hill Book Co., 1986.
- Judge A.W “Modern Electrical Equipment of Automobiles”, Chapman & Hall, 1992
- Kholi.P.L “Automotive Electrical Equipment”, Tata McGraw-Hill Co., Ltd., 1975.
- Robert Bosch “Automotive Hand Book”, Fifth Edition, SAE, 2000
- Ganesan.V. “Internal Combustion Engines”, Tata McGraw-Hill Publishing Co., 2003.

E-REFERENCES

1.http://www.intechopen.com/books/new-advances-in-vehicular-technology-and-automotive-engineering

2.http://nptel.iitm.ac.in/syllabus/syllabus.php?subjectId=125106001

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	3	2	1	3	1	2	2	1	0	1	2	2	
CO2	1	3	1	3	2	1	1	1	3	0	2	1	2	
CO3	1	1	2	1	2	2	3	3	1	2	3	1	2	
CO4	0	1	2	1	2	2	2	1	1	1	3	2	2	
CO5	2	3	2	2	2	1	2	1	1	2	3	2	2	
TOT	4	11	9	8	11	7	10	8	7	5	12	8	10	

1 - Low , 2 – Medium , 3- High

Semester	**TRACK-III**		
Subject Name	**Reliability Engineering**		
Subject Code	**XMEE25**		
L –T –P –C	**C:P:A**		**L –T –P –H**
3-0– 0–3	**2.5:0.25:0.25**		**3- 0– 0 –3**
Course Outcome			**Domain/Level C or P or A**
CO1	**Classify** the Reliability and **uses** Failure data, failure modes, and reliability in terms of hazard rate and failure density function;Hazard models and bath tub curve; applicability of Weibull distribution		C(Understanding) A(Receiving)

CO2	**Make use of** Maintenance - its role and scope in total organisational context basic guidelines for design of organisation structure for **follows** maintanence; Centralised vs decentralised maintenance;	C(Apply) A(Valuing)
CO3	**Examine** the corrective, planned, preventive and predictive maintenance; opportunistic maintenance; Measurement of maintenance work **Identifies** the, Reliability and Human Engineering , Reliability Management	C(Analyze) A(Organization)
CO4	**Analysis** the Maintenance Theory –Inspection and **verify** the Failure Diagnosis Markov Maintenance Process	C(Analyze) A(Valuing, Set)
CO5	**Recall** the Basic laws of probability, Conditional probability, Random variable, sample distribution, statistical hypothesis, statistical tests of significance, correlation, regression **compare** the ANNOVA theory and SWOT	C(Remembering) A(Organization)

COURSE CONTENT

UNIT I	**Reliability: Definition and basic concepts**	**9 hrs**

Reliability: Definition and basic concepts; Failure data, failure modes, and reliability in terms of hazard rate and failure density function;Hazard models and bath tub curve; applicability of Weibull distribution. Reliability calculations for series, parallel and parallel-series systems; Reliability calculations for maintained and stand-by systems.

UNIT II	**Maintenance and Role of reliability**	**9 hrs**

Maintenance - its role and scope in total organisational context. Objectives and characteristics of maintenance; basic guidelines for design of organisation structure for maintanence; Centralised vs decentralised maintenance;

UNIT III	**Reliability Management and preventive maintenance**	**9 hrs**

Types of maintenance - corrective, planned, preventive and predictive maintenance; Factors affecting maintenance; opportunistic maintenance; Measurement of maintenance work; rating and allowances. Maintenance cost budgets. Maintenance planning and scheduling; MIS in maintenance; Measurement of maintenance effectiveness and maintenance audit. Applied Reliability -Reliability Testing, Reliability and Human Engineering , Reliability Management

UNIT IV	**Advanced reliability**	**9 hrs**

Advanced Maintenance Theory -Inspection(Surveillance) Policies -Failure Diagnosis Markov Maintenance Process

UNIT V	**Basic laws of probability ANNOVA concept**	**9 hrs**

Basic laws of probability, Conditional probability, Random variable, sample distribution, statistical hypothesis, statistical tests of significance, correlation, regression analysis, autocorrelation, ANOVA, concept of reliability, availability and maintainability (RAM),

systems reliability, reliability improvement, design of maintenance systems, spare parts management, Decision Support System, SWOT.

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

1. Mechanical Reliability Engineering by ADS Carter, Macmilan

REFERENCES

1.Reliability Evaluation of Engineering Systems by Roy Billington and R.N. Allen, Pitman

2. Reliabilities for the Technologies by L.A.Doty, Industrial Press Inc.Kyung S. Park

E-REFERENCES

1. NPTEL; IITM/IITK Reliability theory

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**2**	
CO2	**3**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**2**	
CO3	**3**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**2**	
CO4	**3**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**2**	
CO5	**3**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**1**	**1**	**2**	
	15	**4**	**7**	**5**	**5**				**7**		**2**	**5**	**10**	

1 - Low , 2 – Medium , 3- High

SEMESTER-WISE STRUCTURE OF CURRICULUM

B.TECH – PART TIME PROGRAMME

REGULATIONS – 2019

(Applicable to the students admitted from the Academic year 2019-20)

SEMESTER I

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
PMA101	Basic Science course	Mathematics –I (Calculus & Linear Algebra)	3	1	0	4
PEM102	Engineering Science courses	Engineering Mechanics	3	1	0	4
PME103	Professional Core courses	Materials Engineering	3	0	0	3
PME104		Thermodynamics	3	1	0	4
PUM105*	Mandatory Courses*	Environmental Science	-	-	-	0
	TOTAL					**15**

*Self study

SEMESTER II

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
PMA201	Basic Science course	Mathematics –II (ODE& Complex Variables)	3	1	0	4
PME202	Professional Core courses	Applied Thermodynamics	3	1	0	4
PME203		Fluid Mechanics & Fluid Machines	3	1	0	4
PME204		Manufacturing Processes	3	0	0	3
PUM205*	Mandatory courses*	Constitution of India	-	-	-	0
	TOTAL					**15**

*Self study

SEMESTER III

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
PMA301	Basic Science Courses	Mathematics III (PDE, Probability & Statistics)	3	1	0	4
PME302	Professional Core Courses	Heat Transfer	3	1	0	4
PME303		Strength of Materials	3	1	0	4
PME304		Mechanical Engineering Laboratory (Thermal) I	0	0	3	1.5
PUM305*	Mandatory course	Essence of Indian Traditional Knowledge	0	0	0	0

	TOTAL				**13.5**

*Self study

SEMESTER IV

Sub. Code	**Category**	**Name of the Course**	**Hours per week**			**C**
			L	**T**	**P**	
PME401	Professional Core courses	Instrumentation & Control	3	1	0	4
PME402		Kinematics & Theory of Machines	3	1	0	4
PME403		Solid Mechanics	3	1	0	4
PME404		Mechanical Engineering Laboratory (Design) II	0	0	3	1.5
PUM405*	Humanities courses	Professional ethics and human values	3	0	0	3
	TOTAL					**16.5**

*Self study

SEMESTER V

Sub. Code	**Category**	**Name of the Course**	**Hours per week**			**C**
			L	**T**	**P**	
PME501	Professional Core courses	Manufacturing Technology	4	0	0	4
PME502		Design of Machine Elements	3	1	0	4
PME503	Professional Elective courses	Elective-I	3	0	0	3
PME504		Elective-II	3	0	0	3
PUM505*	Humanities courses	English	3	0	0	3
	TOTAL					**17**

*Self study

SEMESTER VI

Sub. Code	**Category**	**Name of the Course**	**Hours per week**			**C**
			L	**T**	**P**	
PME601	Professional Core courses	Automation in Manufacturing	3	0	0	3
PME602	Professional Elective courses	Elective III	3	0	0	3
PME603		Elective-IV	3	0	0	3
PME604	Professional Core courses	Mechanical Engineering Laboratory III (Manufacturing)	0	0	3	1.5
PUM605	Humanities and Social Sciences	Open Elective-III – Operations Research	3	0	0	3
	TOTAL					**13.5**

SEMESTER VII

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
PME701	Professional Elective courses	Elective V	3	0	0	3
PME702	Project	Project Work	0	0	12	6
		TOTAL				**9**

TOTAL CREDITS – 99.5

LIST OF ELECTIVES

ELECTIVE I

* Elective Code	Course Title	L	T	P	C
PME503A	Refrigeration& Air conditioning	3	0	0	3
PME503B	Fluid Power Engineering	3	0	0	3
PME503C	Energy Conversion Systems	3	0	0	3
PME503D	Metrology and Measurements	3	0	0	3

ELECTIVE II

* Elective Code	Course Title	L	T	P	C
PME504A	Nano Technology	3	0	0	3
PME504B	CAD/CAM	3	0	0	3
PME504C	Tribology	3	0	0	3
PME504D	Thermal Engineering	3	0	0	3

ELECTIVE III

* Elective Code	Course Title	L	T	P	C
PME602A	Automobile Engineering	3	0	0	3
PME602B	Computational Fluid Dynamics	3	0	0	3
PME602C	Finite Element Analysis	3	0	0	3
PME602D	Optimum Utilization of Heat and Power	3	0	0	3

ELECTIVE IV

* Elective Code	Course Title	L	T	P	C
PME603A	Automation and Control Engineering	3	0	0	3
PME603B	Modern Manufacturing Technology- JIT, AMT	3	0	0	3
PME603C	Reliability Engineering	3	0	0	3
PME603D	Advanced I.C Engines	3	0	0	3

ELECTIVE V

* Elective Code	Course Title	L	T	P	C
PME701A	Power Plant Engineering	3	0	0	3
PME701B	Mathematical Modeling and simulation-MATLAB	3	0	0	3
PME701C	Engineering Economics & Cost analysis	3	0	0	3
PME701D	Materials Management & Industrial Engineering	3	0	0	3

B.TECH REGULATION 2019 (PART TIME)

SYLLABUS

Semester	Course name	Course Code	`L	T	P	C
I	MATHEMATICS 1 (Calculus and Linear Algebra)	PMA101	3	1	0	4

Course outcome		Domain
CO1	Apply differential and integral calculus to notions of curvature and to improper integrals.	Cognitive
CO2	State Rolle's theorem, Mean value theorems, Taylors and Maclaurin theorems with remainders and to apply L'Hospital's rule.	Cognitive
CO3	Apply power series to tests the convergence of the sequences and series and to find the half range fourier sine and cosine series.	Cognitive
CO4	Find maxima, minima and saddle points using method of Lagrange multipliers and to find directional derivatives, gradient, curl and divergence.	Cognitive
CO5	Find eigen values and eigen vectors and to state and verify cayley Hamilton theorem and to use orthogonal transformation to diagonalise the matrix.	Cognitive

COURSE CONTENT		Hours
UNIT I	CALCULUS	9+3
	Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	
UNIT II	CALCULUS	9+3
	Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and Minima.	
UNIT III	SEQUENCES AND SERIES	9+3
	Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.	
UNIT IV	MULTIVARIABLE CALCULUS (DIFFERENTIATION)	9+3
	Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.	
UNIT V	MATRICES	9+3
	Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigen values and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.	

TEXT BOOKS /REFERENCE BOOKS

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,

2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Mapping of COs with PO

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7

1 - Low, 2 – Medium, 3- High

Semester	**Course name**	**Course Code**	**`L**	**T**	**P**	**C**
I	**Engineering Mechanics**	**PEM102**	**3**	**1**	**0**	**4**

Course outcomes		**Domain**
CO1	***Explain*** the principles forces, laws and their applications.	Cognitive-Understanding Apply
CO2	***Classification*** of friction, and ***apply*** the forces in Trusses and beams.	Cognitive-Understanding Apply
CO3	***Explain*** and ***Apply*** moment of Inertia and Virtual work	Cognitive-Understanding Apply
CO4	***Outline*** and ***Examine*** Dynamics	Cognitive-Understanding Apply
CO5	***Explain*** free and forced vibration	Cognitive-Remember Understanding

COURSE CONTENT		Hours
UNIT I	**INTRODUCTION TO ENGINEERING MECHANICS**	**9+6**
	Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy	
UNIT II	**FRICTION AND BASIC STRUCTURAL ANALYSIS**	**9+6**
	Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines	
UNIT III	**CENTROID , CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD**	**9+6**
	Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook. Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.	
UNIT IV	**REVIEW OF PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS OF RIGID BODIES**	**9+6**
	Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.	
UNIT V	**MECHANICAL VIBRATIONS**	**9+6**
	Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums	

TEXT BOOKS /REFERENCE BOOKS

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford

University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Upon successful completion of the course, student will have:

- Ability to apply mathematics, science, and engineering
- Ability to design and conduct experiments, as well as to analyze and interpret data
- Ability to identify, formulate, and solve engineering problems
- Ability to apply modern engineering tools, techniques and resources to solve complex mechanical engineering activities with an understanding of the limitations.
- Ability to comprehend the thermodynamics and their corresponding processes that influence the behavior and response of structural components
- Ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) and thermodynamics to model, analyze, design, and realize physical systems, components, or processes

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES												**PSO1**	**PSO2**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO2	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO3	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO4	3	2	1	1	3	1	1	2	3	2	1	3	2	
CO5	2	2	2	1	3	1	1	3	3	3	1	3	2	

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	**Course name**	**Course Code**	**`L**	**T**	**P**	**C**
I	**Materials Engineering**	**PME103**	**3**	**0**	**0**	**3**

Course outcome		**Domain**
CO1	***Recall*** the Basic Properties of Engineering Materials.	Cognitive
CO2	***Classify*** static failure theories.	Cognitive
CO3	***Classify*** the concepts of iron and steel.	Cognitive
CO4	***Analyze*** the heat treatment process and its applications.	Cognitive

CO5	***Analyze*** the properties of alloys.	Cognitive

COURSE CONTENT		**Hours**
UNIT I	**` PROPERTIES OF METALLIC MATERIALS**	**9**
	Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids:Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slipsystems, critically resolved shear stress.Mechanical Property measurement: Tensile, compression and torsion tests; Young'smodulus, relations between true and engineering stress-strain curves, generalized Hooke'slaw, yielding and yield strength, ductility, resilience, toughness and elastic recovery;Hardness: Rockwell, Brinell and Vickers and their relation to strength.	
UNIT II	**STATIC FAILURE THEORIES**	**9**
	Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximumnormal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT).	
UNIT III	**ALLOYS AND PHASE DIAGRAMS**	**9**
	Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.	
UNIT IV	**HEAT TREATMENT OF MATERIALS**	**9**
	Heat treatment of Steel: Annealing, tempering, normalizing and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties-austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening	
UNIT V	**MODERN ENGINEERING MATERIALS**	**9**
	Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys.	

TEXT BOOKS

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition,Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

REFERENCES

1. Koch, C. C. Nanostructured materials: processing and applications: William Andrew Pub.
2.James F Shackelford, S "Introduction to materials Science for Engineers", 6 th Macmillan Publishing Company, New York, 2004
3.William D CallisterJr, "Materials Science and Engineering – An Introduction", John Wiley and Sons Inc., 6 th edition, New York, 2003
4.Jayakumar S, "Materials Science", RK Publishers, Coimbatore, 2004
5. Bolton, W., Engineering materials technology: Butterworth-Heinemann.

E RESOURCES

1.NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering &Metallurgy and Material Science categories
2.http://www.intechopen.com/books

TABLE 1: Mapping of CO's with PO'S:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	3	3	1	1	-	2	3	3	1	3	2	2
CO2	3	3	1	1	1	-	-	1	1	2	3	2	3	1
CO3	3	2	1	1	1	-	-	1	2	3	1	3	3	1
CO4	2	3	1	3	1	-	-	1	1	2	3	2	3	2
CO5	3	2	3	3	1	1	-	1	3	3	2	1	2	2

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	**Course name**	**Course Code**	**`L**	**T**	**P**	**C**
I	**Thermodynamics**	**PME104**	**3**	**1**	**0**	**4**

Course outcome		**Domain**
CO1	After completing this course, the students will be able to *apply* energy balance to systems and control volumes, in situations involving heat and work interactions	Cognitive
CO2	Students can *Study the* changes in thermodynamic properties of substances	Cognitive
CO3	The students will be able to *study* the performance of energy conversion devices	Cognitive
CO4	The students will be able to *differentiate* between high grade and low grade energies.	Cognitive
CO5	Student can *apply* the exergy balance to systems operating at different cycles.	Cognitive

COURSE CONTENT		**Hours**
UNIT I	**BASIC CONCEPTS**	**12**
	Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.	
UNIT II	**LAWS OF THERMODYNAMICS**	**12**
	Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy	

UNIT III	**PROPERTIES OF SUBSTANCES AND STEAM TABLES**	**12**
	Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.	
UNIT IV	**FLOW PROCESS AND THERMO DYNAMIC RELATIONS**	**12**
	First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.	
UNIT V	**ENTROPY AND CYCLES**	**12**
	Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.	

TEXT BOOKS /REFERENCE BOOKS

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES												PSO1	PSO2
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	2	-	1	-	3	-	2	2	2	-	-	2		3
CO2	3	-	-	2	3	-	1	-	1	-	-	3		3
CO3	1	-	1	3	1	-	1	2	-	2	-	1		3
CO4	2	-	-	1	1	-	2	1	2	2	-	1		3
CO5	-	-	-	1	1	-	-	-	1	1	-	2		3

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	Course name	Course Code	`L	T	P	C
I	Environmental Science	PUM105*	-	-	-	0

COURSE OUTCOMES:		Domain	Level
CO1	***Describe*** the significance of natural resources and ***explain*** anthropogenic impacts.	Cognitive	Remember Understand
CO2	***Illustrate*** the significance of ecosystem, biodiversity and natural geo bio chemical cycles for maintaining ecological balance.	Cognitive	Understand
CO3	***Identify*** the facts, consequences, preventive measures of major pollutions and ***recognize*** the disaster phenomenon.	Cognitive Affective	Remember Receiving
CO4	***Explain*** the socio-economic, policy dynamics and ***practice*** the control measures of global issues for sustainable development.	Cognitive	Understand Analyse
CO5	***Recognize*** the impact of population and the concept of various welfare programs, and ***apply*** the modern technology towards environmental protection.	Cognitive Psychomotor	Understand Apply

UNIT - I INTRODUCTION TO ENVIRONMENTAL STUDIES AND ENERGY **12**

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, flood, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

UNIT - II ECOSYSTEMS AND BIODIVERSITY **7**

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III ENVIRONMENTAL POLLUTION **10**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: flood, earthquake, cyclone and landslide.

UNIT –IV SOCIAL ISSUES AND THE ENVIRONMENT **10**

Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation – Consumerism and waste products – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT –V HUMAN POPULATION AND THE ENVIRONMENT **6**

Population growth, variation among nations – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education - HIV / AIDS – Women and Child welfare programme– Role of Information Technology in Environment and human health – Case studies.

LECTURE	TUTORIALS	PRACTICALS	TOTAL
45	0	-------	45

TEXT BOOKS

1. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co, USA, (2000).
2. Townsend C., Harper J and Michael Begon, Essentials of Ecology, Blackwell Science, UK, (2003).
3. Trivedi R.K and P.K.Goel, Introduction to Air pollution, Techno Science Publications, India, (2003).
4. Disaster mitigation, Preparedness, Recovery and Response, SBS Publishers & Distributors Pvt. Ltd, New Delhi, (2006).
5. Introduction to International disaster management, Butterworth Heinemann, (2006).
6. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, New Delhi, (2004).

REFERENCES

1. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media, India, (2009).
2. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, (2001).
3. S.K.Dhameja, Environmental Engineering and Management, S.K.Kataria and Sons, New Delhi, (2012).
4. Sahni, Disaster Risk Reduction in South Asia, PHI Learning, New Delhi, (2003).
5. Sundar, Disaster Management, Sarup & Sons, New Delhi, (2007).
6. G.K.Ghosh, Disaster Management, A.P.H.Publishers, New Delhi, (2006).

E RESOURCES

1. http://www.e-booksdirectory.com/details.php?ebook=10526
2. https://www.free-ebooks.net/ebook/Introduction-to-Environmental-Science
3. https://www.free-ebooks.net/ebook/What-is-Biodiversity
4. https://www.learner.org/courses/envsci/unit/unit_vis.php?unit=4
5. http://bookboon.com/en/pollution-prevention-and-control-ebook
6. http://www.e-booksdirectory.com/details.php?ebook=8557
7. http://www.e-booksdirectory.com/details.php?ebook=6804
8. http://bookboon.com/en/atmospheric-pollution-ebook
9. http://www.e-booksdirectory.com/details.php?ebook=3749
10. http://www.e-booksdirectory.com/details.php?ebook=2604
11. http://www.e-booksdirectory.com/details.php?ebook=2116
12. http://www.e-booksdirectory.com/details.php?ebook=1026
13. http://www.faadooengineers.com/threads/7894-Environmental-Science

Mapping of COs with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3											1
CO2	2					2	1			1		1
CO3	2	1	3			3	1		2	1		1
CO4	1	1	2			3	2	3				1
CO5	2	1	1			3						1
Total	**10**	**3**	**6**			**11**	**4**	**3**	**2**	**2**		**5**

1 - Low, 2 – Medium, 3- High

Semester	Course name	Course Code	`L	T	P	C
II	MATHEMATICS 1I (ODE & Complex Variables)	PMA201	3	1	0	4

Course outcome		Domain
CO1	Apply Greens theorem, Gauss divergence theorem, Stokes theorem to find area and volume using multiple integrals in Cartesian form by having simple applications involving cubes, sphere and rectangular parallelepipeds.	Cognitive
CO2	Solve first order differential equations of different types which are solvable for p, y, x and Clairaut's type.	Cognitive
CO3	Solve second order ordinary differential equations with variable coefficients using method of variation of parameters, Cauchy Euler equation, power series, Legendre polynomials and Bessel functions of the first kind.	Cognitive
CO4	Use CR equations to verify analytic functions, harmonic functions, find harmonic conjugate and to find conformal mapping of translation and rotation.	Cognitive
CO5	Apply Cauchy residue theorem to evaluate contour integrals involving sine and cosine function and to state Cauchy integral formula, Liouvilles theorem.	Cognitive

COURSE CONTENT		Hours
UNIT I	**Multivariable Calculus (Integration)**	9+3
	Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.	
UNIT II	**First order ordinary differential equations:**	9+3
	Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.	
UNIT III	**Ordinary differential equations of higher orders**	9+3
	Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.	
UNIT IV	**Complex Variable – Differentiation**	9+3
	Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	
UNIT V	**Complex Variable – Integration**	9+3
	Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	

TEXT BOOKS /REFERENCE BOOKS

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
4. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
5. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
7. (vii)J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc- Graw Hill, 2004.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Mapping of COs with PO

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7

1 - Low, 2 – Medium, 3- High

Semester	Course name	Course Code	`L	T	P	C
II	**Applied Thermodynamics**	**PME202**	**3**	**1**	**0**	**4**

Course outcome		**Domain**
CO1	Understanding of basic fuel types and Calculation of air fuel mixtures or combustion	Cognitive
CO2	After completing this course, the students will get a good understanding of various practical power cycles and heat pump cycles.	Cognitive
CO3	Understanding of basic principles of psychrometry and solving the problems of psychrometric chart.	Cognitive
CO4	They will be able to understand phenomena occurring in high speed compressible flow	Cognitive
CO5	They will be able to analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors.	Cognitive

COURSE CONTENT		Hours
UNIT I	**Fuels and Stoichiometry**	**8**
	Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy	
UNIT II	**Power cycles**	**12**
	Vapor power cycles Rankine cycle with superheat, reheat and regeneration, enregy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties	
UNIT III	**Psychyrometry**	**4**
	Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.	
UNIT IV	**Compressible flow and Shocks**	**8**
	Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle,supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser	
UNIT V	**Compressors and Steam turbines**	**8**
	Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors and Analysis of steam turbines, velocity and pressure compounding of steam turbines	

TEXT BOOKS /REFERENCE BOOKS

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES												PSO1	PSO2
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	3	2	1	2	0	0	0	1	3	0	3	3		3
CO2	3	3	1	0	2	0	0	2	3	0	3	3		3

CO3	3	3	1	1	1	0	0	2	3	0	3	3		3
CO4	3	3	1	0	0	0	0	0	3	0	3	3		3
CO5	1	2	1	0	0	0	0	3	3	0	3	3		3

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	**Course name**	**Course Code**	**`L**	**T**	**P**	**C**
I1	**Fluid Mechanics And Machines**	**PME203**	**3**	**1**	**0**	**4**

Course outcome		**Domain**
CO1	**Recalling** of fluids properties and **understanding** the equations related to fluid flow. Ability to **solve** problems related to momentum equation and Bernoulli's equation	**Cognitive-** Remembering, understanding and apply
CO2	**Understanding** the concept of incompressible fluid flow fluid flow through channels and ducts. **Discuss** the concept of boundary layer and ability **apply** Darcy Weisbach equation in different condition	**Cognitive-** Understanding and apply
CO3	**Understanding** the need and methods of dimensional analysis and ability to **derive** equations using dimensional analysis	**Cognitive-** Understanding and apply
CO4	**Explain** the working of different types of pumps and ability to **analyze** its performance	**Cognitive-** Understanding analyze and apply
CO5	**Explain** the working of different types of turbines and ability to **analyze** its performance	**Cognitive-** Understanding analyze and apply

COURSE CONTENT		**Hours**
UNIT I	**BASIC CONCEPTS AND PROPERTIES OF FLUIDS**	**9**
	Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications	
UNIT II	**IN COMPRESSIBLE FLUID FLOW**	**9**
	Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram	
UNIT III	**DIMENSIONAL ANALYSIS**	**6**
	Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis	

UNIT IV	**HYDRAULIC PUMPS**	**8**
	Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle	
UNIT V	**HYDRAULIC TURBINES**	**8**
	Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines	

TEXT BOOKS /REFERENCE BOOKS

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 2003.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.
3. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 2008.
4. Som, S.K., and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2004.
5. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 2005.

Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, 2008.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES												**PSO1**	**PSO2**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	3	3	1	1	3	1	1	1	1	1	1	1		2
CO2	3	3	2	1	3	1	1	2	2	2	1	2		2
CO3	3	3	0	1	3	1	0	2	1	1	0	1		2
CO4	3	3	1	2	3	1	1	2	2	2	1	2		2
CO5	3	3	2	2	3	1	1	2	2	2	1	2		2
Total	15	15	6	7	15	5	4	9	10	10	4	8		10

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	Course name	Course Code	`L	T	P	C
II	Manufacturing Processes	PME204	3	0	0	3

Course outcome		Domain
CO1	***Analyze*** and ***identify*** the basic process of foundry.	Cognitive Psychomotor
CO2	***List*** the forging operations and ***distinguish*** hand forging with power forging.	Cognitive Psychomotor
CO3	***Recall*** the traditional metal joining processes and ***relate*** them with respect to the advantages and applications.	Cognitive Psychomotor
CO4	***Classify*** and ***select*** the suitable machining processes.	Cognitive Psychomotor
CO5	***Compare*** the types of plastics and ***choose*** the suitable plastic moulding processes.	Cognitive Psychomotor

COURSE CONTENT		Hours
UNIT I	**FOUNDRY**	14
	Foundry – Pattern – pattern making – pattern materials – types of patterns –moulding tools – moulding sand – properties of moulding sand – moulding processes – moulding procedure – flow of molten metal in the mould.	
UNIT II	**FORGING**	14
	Forging and its applications – classification of forging processes – hot working, cold working, hand forging and power forging – hand forging tools – hand forging operations.	
UNIT III	**WELDING**	14
	Metal joining processes – welding– types of welding – gas welding-oxy acetylene welding – gas welding equipment – types of flames – electric arc welding – arc welding equipments – types of welded joints – brazing and its types.	
UNIT IV	**MACHINING**	14
	Lathe – working principle – description and functions of lathe parts – specification of lathe – work holding and supporting devices – speed, cutting speed, feed and depth of cut – drilling – drilling machine and its types – components of sensitive and upright drilling machine.	
UNIT V	**PROCESSING OF PLASTICS**	14
	Plastics – types of plastics – processing of thermo plastics – extrusion, inspection blow, rotatromal moulding processes – thermo forming – processing of thermosets – compression, transfer moulding processes.	

TEXT BOOKS /REFERENCE BOOKS

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.

4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES												PSO1	PSO2
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	3	3	3	3	2	2	-	1	-	1	2	2	3	
CO2	3	3	3	3	2	2	-	1	-	1	2	2	3	
CO3	3	3	3	3	2	2	-	1	-	1	2	2	3	
CO4	3	3	3	3	2	2	-	1	-	1	2	2	3	
CO5	3	3	3	3	2	2	-	1	-	1	2	2	15	

Correlation level - 1 – Low 2 – Medium 3 – High

Semester	Course name	Course Code	`L	T	P	C
II	**Constitution of India**	**PUM205***	**-**	**-**	**-**	**0**

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation

7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.

Semester	Course name	Course Code	`L	T	P	C
III	**Mathematics-III (PDE, Probability & Statistics)**	**PMA301**	**3**	**1**	**0**	**4**

Course outcome		**Domain**
CO1	Solve homogeneous and non homogeneous linear partial differential equations of second order by complementary function and particular integral method.	Cognitive
CO2	Solve one dimensional heat equation, wave equation using separation of variables method to simple problems in Cartesian coordinates.	Cognitive
CO3	Explain conditional probability independence of events, Discrete random variables, continuous random variables, Poisson approximation to the binomial distributions and to find Marginal and conditional density functions.	Cognitive
CO4	Find statistical parameters of the Binomial, Poisson and Normal distributions and to find correlation, regression and rank correlation coefficients of two variables.	Cognitive
CO5	Apply large sample test for single proportion, difference of proportions, single mean, difference of means and to test ratio of variances, Chi square.	Cognitive

COURSE CONTENT		**Hours**
UNIT I		**14**
	Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One	

	dimensional diffusion equation and its solution by separation of variables	
UNIT II		**12**
	Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables	
UNIT III		**12**
	Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.	
UNIT IV		**12**
	Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance:	
UNIT V		**12**
	Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	

TEXT BOOKS /REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Mapping of COs with PO

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	2	1						1	1		1
CO2	3	2	1						1	1		1
CO3	3	2	1	1					1	1		1
CO4	3	2	1	1	1	1			1	1	1	1
CO5	3	2	1	1	1	1	1		1	1	1	1
Total	15	10	5	3	2	2	1		5	5	2	5

1 - Low, 2 – Medium, 3- High

Semester	Course name	Course Code	`L	T	P	C
III	HEAT TRANSFER	PME302	3	1	0	4

Course outcome		Domain
CO1	Understand the basic modes of heat transfer and Compute temperature distribution in steady-state and unsteady-state heat conduction.	C (Rem)
CO2	Understand the conduction in pin fins	C (Rem)
CO3	Interpret and analyse forced and free convection heat transfer.	C (Rem)
CO4	Understand the principles of radiation heat transfer and basics of mass transfer.	C (Understand)
CO5	Understand the basic concepts of mass transfer	C (understand)

COURSE CONTENT		Hours
UNIT I	**CONDUCTION**	6
	Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number.	
UNIT II	**CONDUCTION IN PIN FINS**	6
	heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts	
UNIT III	**CONVECTION**	8
	Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.	
UNIT IV	**RADIATION**	8
	Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method	
UNIT V	**HEAT EXCHANGERS AND MASS TRANSFER**	12
	Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε- NTU methods. Boiling and Condensation heat transfer, Pool boiling curve Introduction mass transfer, Similarity between heat and mass transfer	

TEXT BOOKS /REFERENCE BOOKS
1. A. Bejan, Heat Transfer John Wiley, 1993 2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997. 3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007. 4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002 5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	1	-	-	1		2
CO2	3	2	-	2	1	1		-	-	-	-	1		2
CO3	2	3	3	2	1	1	1	-	1	-	-	1		2
CO4	2	3	3	2	1	1	1	-	1	-	-	1		2
CO5	3	2	2	1	1	1	1	-	-	-	-	1		2
Total	13	12	14	9	5	4	3		3			5		10

1 - Low, 2 – Medium, 3- High

Semester	Course name	Course Code	`L	T	P	C
III	**Strength of Materials**	**PME303**	**3**	**1**	**0**	**4**

Course outcome		**Domain**
CO1	After completing this course, the students should be able to recognize various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components	Cognitive
CO2	The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading	Cognitive
CO3	The students will be able to understand inertia and different types of springs and evaluate the different types of inertia and deflection of different types of beams with different loading conditions.	Cognitive
CO4	The students will be able to understand torsion on shaft and springs and evaluate deflection, torsional stresses on shaft, helical spring and leaf spring	Cognitive
CO5	After completing this course, The students will be able to understand and compute stresses in hollow cylindrical and spherical objects.	Cognitive

COURSE CONTENT		Hours
UNIT I	**STRESS, STRAIN AND DEFORMATION OF SOLIDS**	**8**
	Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle	
UNIT II	**BEAMS - LOADS AND STRESSES**	**8**
	Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads	
UNIT III	**DEFLECTION OF BEAMS**	**8**
	Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems	
UNIT IV	**TORSION AND SHAFTS**	**8**
	Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs	
UNIT V	**ANALYSIS OF STRESSES IN TWO DIMENSIONS**	**8**
	Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure	

TEXT BOOKS /REFERENCE BOOKS

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES												PSO1	PSO2
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO2	3	3	2	3	3	1	2	1	2	1	3	3	2	
CO3	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO4	3	3	2	3	3	1	2	1	2	1	2	3	2	
CO5	3	3	2	3	3	1	2	1	2	1	3	3	10	

Correlation level - 1 – Low 2 – Medium 3 – High

PME304	Mechanical Engineering Laboratory (Thermal) I	0L:0T:3P	1.5 credits

Objectives:

(i) To understand the principles and performance characteristics of flow and thermal devices

(ii) To know about the measurement of the fluid properties

Contents:

1. Measurement of Coefficient of Discharge of given Orifice and Venturi meters
2. Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe
3. Determination of the performance characteristics of a centrifugal pump
4. Determination of the performance characteristics of Pelton Wheel
5. Determination of the performance characteristics of a Francis Turbine
6. Determination of the performance characteristics of a Kaplan Turbine
7. Determination of the thermal conductivity and specific heat of given objects
8. Determination of the calorific value of a given fuel and its flash & fire points
9. Determination of the p-V diagram and the performance of a 4-stroke diesel engine
10. Determination of the convective heat transfer coefficient for flow over a heated plate
11. Determination of the emissivity of a given sample
12. Determination of the performance characteristics of a vapour compression system

Course Outcomes:

The students who have undergone the course will be able to measure various properties of fluids and characterize the performance of fluid/thermal machinery

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1		3
CO2	2	3	-	2	1	1	-	-	-	-	-	1		3
CO3	2	3	-	2	1	1	-	-	1	-	-	1		3
CO4	2	3	2	1	1	1	-	-	1	-	-	1		3
CO5	2	3	-	2	1	1	-	-	-	-	-	1		3
	10	15	2	9	5	5			3			5		15

1 - Low, 2 – Medium, 3- High

PUM305*	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**	**0L:0T:0P**	**0 credits**

Course objective

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-I focuses on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health care system.

Course Contents

1. Basic structure of Indian Knowledge System
2. Modern Science and Indian Knowledge System
3. Yoga and Holistic Health care
4. Case studies

References

Knowledge traditions and practices of India, CBSE Publication

1. V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
2. Swami Jitatmanand, *Modern Physics and Vedant*haratiya Vidya Bhavan
3. Swami Jitatmanand, *Holistic Science and Vedant*haratiya Vidya Bhavan
4. Fritzof Capra, *Tao of Physics*
5. Fritzof Capra, *The Wave of life*
6. VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
7. *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
8. GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
9. RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
10. P B Sharma (English translation), *Shodashang Hridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Outcome: Ability to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.

Semester	Course name	Course Code	`L	T	P	C
IV	Instrumentation and Control	PME401	3	1	0	4

COURSE CONTENT		Hours
UNIT I	**Measurement systems and Characteristics**	9
	Measurement systems and performance – accuracy, range, resolution, error sources.	
UNIT II	**Instrumentation systems and elements**	9
	Instrumentation system elements – sensors for common engineering measurements; Signal processing and conditioning; correction elements- actuators: pneumatic, hydraulic, electric.	
UNIT III	**Controllers**	8
	Control systems – basic elements, open/closed loop, design of block diagram; control method P, PI, PID, when to choose what, tuning of controllers.	
UNIT IV	**Models**	8
	System models, transfer function and system response, frequency response; Nyquist diagrams and their use.	
UNIT V	**Project**	6
	Practical group based project utilizing above concepts.	

TEXT BOOKS /REFERENCE BOOKS

1. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 200
2. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V , Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2007
3. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999.

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1													1	1
CO2													1	1
CO3													1	1
CO4													1	1
CO5													1	1
Tot													5	5

1 - Low, 2 – Medium, 3- High

Semester	Course name	Course Code	`L	T	P	C
IV	Kinematics & Theory of Machines	PME402	3	1	0	4

COURSE CONTENT		Hours
UNIT I	**BASICS OF MECHANISMS**	8+4
	Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms	
UNIT II	**KINEMATICS OF PLANE MECHANISMS**	8+2
	Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation	
UNIT III	**CAMS**	8+2
	Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers	
UNIT IV	**GEARS**	8+2
	Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics	
UNIT V	**FRICTION IN BEARING CLUTHES AND BRAKES**	8+2
	Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes	

TEXT BOOKS /REFERENCE BOOKS

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi, 1988.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	2	1	-	2	1	-	2	3	2	
CO2	3	2	3	-	2	1	-	2	1	-	2	3	2	

CO3	3	2	3	-	2	1	-	1	1	-	2	3	2	
CO4	3	2	3	-	3	1	-	2	2	-	2	3	2	
CO5	3	2	2	-	3	1	-	2	1	-	2	3	2	
	15	**9**	**12**	**-**	**12**	**5**	**-**	**9**	**6**	**-**	**10**	**15**	**10**	

1 - Low, 2 – Medium, 3- High

Semester	**Course name**	**Course Code**	**`L**	**T**	**P**	**C**
IV	**Solid Mechanics**	**PME403**	**3**	**1**	**0**	**4**

COURSE CONTENT		**Hours**
UNIT I	**STRAIN**	**15**
	Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress:	
UNIT II	**STRESS**	**15**
	Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions	
UNIT III	**CONSTITUTIVE EQUATIONS**	**15**
	Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.	
UNIT IV	**APPLICATION TO COMPLEX CASES**	**15**
	Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems	
UNIT V	**ENERGY METHODS**	**15**
	Solutions using potentials. Energy methods. Introduction to plasticity.	

TEXT BOOKS /REFERENCE BOOKS

[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.

[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.

[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

Mapping of COs with Pos

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	2	1	-	-	-	1	-	-	-	2	
CO2	3	2	-	2	1	-	-	-	1	-	1	1	2	
CO3	3	1	-	1	1	-	-	1	1	-	1	1	2	
CO4	3	2	-	2	1	-	-	-	1	-	-	-	2	

CO5	3	3	3	3	2	-	-	2	1	-	3	3	2	
	15	10	3	10	6			3	5		5	5	10	

1 - Low, 2 – Medium, 3- High

PME404	**Mechanical Engineering Laboratory (Design) II**	**0L:0T:3P**	**1.5 credits**

Objectives:

(i) To understand the measurement of mechanical properties of materials
(ii) To understand the deformation behaviour of materials
(iii) To understand the kinematic and dynamic characteristics of mechanical devices

Contents

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinnell and Rockwell hardness tests on metallic specimen
5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge
7. Microscopic examination of heat-treated and untreated metallic samples
8. Velocity ratios of simple, compound, epicyclic and differential gear trains
9. Kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms
10. Cam & follower and motion studies
11. Single degree of freedom Spring-mass-damper system, determination of natural frequency and damping coefficient
12. Determination of torsional natural frequency of single and double rotor systems- undamped and damped natural frequencies

MAPPING COs WITH POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO2	2	3	-	2	1	1	-	-	-	-	-	1	2	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	2	
CO4	2	3	2	1	1	1	-	-	1	-	-	1	2	
CO5	2	3	-	2	1	1	-	-	-	-	-	1	2	
Tot	10	15	2	9	5	5			3			5	10	

PUM405* PROFESSIONAL ETHICS AND HUMAN VALUES 3 0 0 3

AIM

To sensitize the engineering students on blending both technical and ethical responsibilities.

OBJECTIVES

- Identify the core values that shape the ethical behavior of an engineer.
- Utilize opportunities to explore one's own values in ethical issues.
- Become aware of ethical concerns and conflicts.
- Enhance familiarity with codes of conduct.
- Increase the ability to recognize and resolve ethical dilemmas.

UNIT I HUMAN VALUES 10

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality.

Unit II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Unit III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study.

Unit IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three mile island and chernobyl case studies.

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

Unit V GLOBAL ISSUES 8

Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE), India, etc.

TOTAL : 45

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New

York 1996.

2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES

1. Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available)
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

Semester	**V**	
Subject Name	**Manufacturing Technology**	
Subject Code	**PME501**	
L –T –P –C	**C:P:A**	**L –T –P –H**
4- 0 – 0– 4	**4:0:0**	**4- 0– 0 – 4**

Course Outcome		**Domain/Level** **C or P or A**
CO1	**Construct** the Degrees of freedom, principles of location and clamping, principles of jig design, fool proofing, elements of jigs, locates fixture design	C(Creating) A(Receiving)
CO2	**Explain** the basic principles of measurements classify the various linear and angular measuring equipments and **distinguish** their principle of operation and applications.	C (Evaluating) P (Perception)
CO3	***Explain*** the Assembly of different components	C (Remembering)
CO4	***Explain*** and demonstrate the basic concepts of PERT- CPM and their applications in product planning control.	C (Understand)
CO5	***Explain*** the basic concepts of optimization and To F***ormulate*** and Solve linear programming problems.	C (understand)

Objectives

(iv) To provide knowledge on machines and related tools for manufacturing various components.

(v) To understand the relationship between process and system in manufacturing domain.

(vi) To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

COURSE CONTENT

UNIT I	**JIGS, FIXTURES AND PRESS TOOLS**	**12 hrs**

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design

UNIT II	**FORM MEASUREMENT**	**16 hrs**

Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as microscale machining, Inspection and workpiece quality

UNIT III	**ASSEMBLY PRACTICES**	**6 hrs**

Manufacturing and assembly, process planning, selective assembly, Material handling and devices

UNIT IV	**LINEAR MODELS,PROJECT SCHEDULING BY PERT-CPM**	**8 hrs**

Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Travelling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks: CPM and PERT, critical path scheduling

UNIT V	**Production planning& control**	**8 hrs**

Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models

L = 50 hrs T = 0 hrs P=0hrs Total = 50 hrs

TEXT BOOKS

1. Donaldson C and Le Cain C H, "Tool Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.

2. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2005

3.Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014

4. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.

5. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

6.Automation, Production Systems, & CIM by Grover; Prentice Hall 2. CAD CAM by C. McMahon and J. Browne; published by Addison-Wesley.

REFERENCES

1. Bhattacharyya A, “Metal Cutting Theory and Practice”, New Central Books Agency (P) Ltd, Calcutta, 2000.

2. Fundamentals of Operations Research, Advanced Operation Research Prof.G.Srinivasan, Department of Management Studies, Indian Institute of Technology, Madras.

3.Modern Production/ Operations Management, E. S. Buffa and R. K. Sarin, John Wiley International, 1994.

E-REFERENCES

http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	-	-	1	-	-	1	3	
CO2	2	2	-	-	-	1	1	-	-	-	-	1	3	
CO3	2	1	-	-	2	1	1	-	-	-	-	1	3	
CO4	2	1	-	-	1	1	1	-	1	-	-	1	3	
CO5	1	-	-	-	1	1	-	-	1	-	-	1	3	
Tot	9	5			4	5	3	3				5	15	

1 - Low, 2 – Medium, 3- High

Semester	**V**		
Subject Name	**Design of Machine Elements**		
Subject Code	**PME502**		
L –T –P –C **3 – 1 – 0– 4**		**C:P:A** **3:1:0**	**L –T –P –H** **3–1– 0 – 4**
Course Outcome			**Domain/Level** **C or P or A**
CO1	Describe the design process, material selection, calculation of stresses and stress concentrations under variable loading.		C (Understand)
CO2	Design the solid, hollow shafts and to finding the critical speeds also have a design knowledge on sliding and rolling contact bearing		C (Synthesis)
CO3	Summarize the knowledge in helical, leaf, disc and torsional springs		C (Understand)
CO4	Analyze bolted joints in eccentric loading. Examine the welded joints for vessels and steel structures. Differentiate rigid and flexible couplings and also the knuckle joints.		C (Analysis)
CO5	Recognize the need for friction drives and positive drives. Apply BIS standards and catalogues in design and selection of belts and chain for requirement, Select suitable drive combination based on requirement.		C (Understand)

Objectives

This course seeks to provide an introduction to the design of machine elements commonly encountered

in mechanical engineering practice, through

- A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
- An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
- An overview of codes, standards and design guidelines for different elements
- An appreciation of parameter optimization and design iteration
- An appreciation of the relationships between component level design and overall machine system design and performance

COURSE CONTENT

UNIT I	**Steady Stresses and Variable Stresses in Machine Members**	**6+0**
	design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure)	
UNIT II	**Shafts and bearings**	**9+3**
	design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings	
UNIT III	**Energy storing Elements**	**6+3**
	helical compression, tension, torsional and leaf springs	
UNIT IV	**Temporary and Permanent Joints**	**9+3**
	threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings	
UNIT V	**Transmission elements**	**15+6**
	spur, helical, bevel and worm gears; belt and chain drives, Analysis of clutches and brakes	
L =45 hrs T=15hrs Total = 60 hrs		

TEXT BOOKS

[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.

[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.

REFERENCES

[1] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.

[2] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994. [5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

E-REFERENCES

2. https://nptel.ac.in/downloads/112105125/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	2	1	2	2	1	2	2	2	2	
CO2	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO3	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO4	3	2	3	1	2	1	2	2	1	2	2	2	2	
CO5	3	2	2	1	2	1	2	2	1	2	2	2	2	
	14	10	14	6	10	5	10	10	5	10	10	10	10	

1 - Low, 2 – Medium, 3- High

Semester	**V**
Subject Name	**English**
Subject Code	**PUM505***

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Ability*** to recall the meaning for proper usage	Cognitive (Remembering)
CO2	***Apply*** the techniques in sentence patterns	Cognitive (Applying)
CO3	***Identify*** the common errors in sentences	Cognitive (Remembering)
CO4	***Construct*** the Nature and Style of sensible Writing	Cognitive(Creating)
CO5	***Practicing*** the writing skills	Psychomotor (Guided response)
CO6	***Grasping*** the techniques in learning sounds and etiquettes	Psychomotor (Adapting)

COURSE CONTENT

UNIT I	**Vocabulary Building**	**9 hrs**

1.1 The concept of Word Formation

1.2 Root words from foreign languages and their use in English

1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form

derivatives

1.4 Synonyms, antonyms, and standard abbreviations.

UNIT II	**Basic Writing Skills**	**9 hrs**

2.1 Sentence Structures

2.2 Use of phrases and clauses in sentences

2.3 Importance of proper punctuation

2.4 Creating coherence

2.5 Organizing principles of paragraphs in documents

2.6 Techniques for writing precisely

UNIT III	**Identifying Common Errors in Writing**	**9 hrs**

3.1 Subject-verb agreement

3.2 Noun-pronoun agreement

3.3 Misplaced modifiers

3.4 Articles

3.5 Prepositions

3.6 Redundancies

3.7 Clichés

UNIT IV	**Nature and Style of sensible Writing**	**9 hrs**

4.1 Describing

4.2 Defining

4.3 Classifying

4.4 Providing examples or evidence

4.5 Writing introduction and conclusion

UNIT V	**Writing Practices**	**9 hrs**

5.1 Comprehension

5.2 Précis Writing

5.3 Essay Writing

UNIT VI **Oral Communication**

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

L = 30 hrs T = 0 hrs P=15 hrs Total = 45 hrs

Suggested Readings

(i) Practical English Usage. Michael Swan. OUP. 1995

(ii) Remedial English Grammar. F.T. Wood. Macmillan.2007

(iii) On Writing Well. William Zinsser. Harper Resource Book. 2001

(iv) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006

(v) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011

(vi) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Mapping of Cos with POs:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO 1	2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO 2	2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO 3	1	0	0	0	0	0	1	0	1	0	0	0	0	0
CO 4	2	0	0	0	0	0	1	0	1	0	0	0	0	0
CO 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot al	7	0	0	0	0	0	6	0	4	0	0	0	0	0

1 - Low, 2 – Medium, 3- High

Semester	**VI**
Subject Name	**Automation in Manufacturing**
Subject Code	**PME601**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Define automation and classify different types of automation along with recent trends of automation in manufacturing.	C (Rem), C(U)
CO2	Classify and describe computer aided technologies in manufacturing.	C (Rem), C(U)
CO3	Classify and explain different automation technologies and building blocks of systems.	C (Rem), C(U)
CO4	Describe product modelling and simulation techniques in manufacturing	C (Rem), C(U)
CO5	Define additive manufacturing and explain the recent advancements in additive manufacturing.	C (Rem), C(U)

Objectives

1. To understand the importance of automation in the of field machine tool based manufacturing

2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC

3. To understand the basics of product design and the role of manufacturing automation

COURSE CONTENT

UNIT I	**BASIC CONCEPTS AND PROPERTIES OF FLUIDS**	**9 hrs**

Introduction: Why automation- Current trends-CAD, CAM, CIM- Rigid automation- Part handling, Machine tools- Flexible automation- Computer control of Machine Tools and Machining Centers-NC and NC part programming, CNC-Adaptive Control- Automated Material handling. Assembly-Flexible fixturing.

UNIT II	**COMPUTERS IN MANUFACTURING**	**9hrs**

Computer Aided Design- Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base-Geometric modelling for downstream applications and analysis methods- Computer Aided Manufacturing- CNC technology- PLC- Micro-controllers-CNC-Adaptive Control

UNIT III	**AUTOMATION**	**9 hrs**

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

UNIT IV	**MODELLING AND SIMULATION**	**9 hrs**

Introduction to Modelling and Simulation-Product design- process route modelling-Optimization techniques-Case studies & industrial applications.

UNIT V Additive Manufacturing 9 hrs

Additive Manufacturing-3Dprinting-Classification of 3D printers-components of basic 3D printer-Preparation of geometry for 3D printing-STL, STEP file generation-Managing of inter exchangeable formats for 3D printing, open source resources for 3D printing.

L = 45 hrs Total = 45 hrs

TEXT BOOKS

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.

2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson

REFERENCES

1. Yoram Koren, Computer control of manufacturing system, 1st edition.

2. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

E-REFERENCES

https://nptel.ac.in/courses/112102011/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	1	-	-	-	1	-	-	-	3	
CO2	3	2	-	2	1	-	-	-	1	-	1	1	3	
CO3	3	1	-	1	1	-	-	1	1	-	1	1	3	
CO4	3	2	-	2	1	-	-	-	1	-	-	-	3	
CO5	3	3	3	3	2	-	-	2	1	-	3	3	3	
	15	10	3	10	6			3	5		5	5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VI**	
Subject Name	**Mechanical engineering laboratory (Manufacturing) III**	
Subject Code	**PME604**	
L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 1.5– 1.5	**0:1.5:0**	**0- 0– 3– 3**

Course Outcome	**Domain/Level** **C or P or A**
Experiment and ***Measure*** various machining operations and its cutting forces involved.	Coginitive (Remembering) (Applying) Psychomotor (Guided response) (Perception)
Create and **choose** the CNC suitable part programming for the corresponding job.	Coginitive (Understanding) Psychomotor (Guided response)
Experiment the sample with EDM.	Coginitive (Understanding) Psychomotor (Perception)
Understand the operation of pick and place robot.	Coginitive (Understanding) Psychomotor (Guided response)
Explain the basic principles of measurements classify the various linear and angular measuring equipments and **distinguish** their principle of operation and applications.	Coginitive (Evaluating) Psychomotor (Perception)

Objectives

1. To provide an understanding of advanced manufacturing methods.

2. To get an idea of the dimensional & form accuracy of products

COURSE CONTENT

		CO Relation
1.	Taper turning and external thread cutting using lathe	CO1
2.	Contour milling using vertical milling machine	CO1
3.	Spur gear cutting in milling machine	CO1
4.	Measurement of cutting forces in Milling/ Turning process	CO1
5.	CNC part programming	CO2
6.	Drilling of a small hole using wire EDM	CO3

7.	Microprocessor controlled pick & place robot	CO4
8.	Use of Tool Maker's Microscope	CO5
9.	Comparator and sine bar	CO5
10.	Surface finish measurement equipment	CO5
11.	Bore diameter measurement using micrometer and telescopic gauge	CO5
12.	Use of Autocollimator	CO5

TEXT BOOKS

1. Hajra Choudhury S.K and Hajra Choudhury. A.K., "Elements of Workshop Technology, Volume I and II", Media Promoters and Publishers Private Limited, Mumbai.
2. HMT – "Production Technology", Tata McGraw-Hill, 1998.Dr. B.C.Punmia, "Surveying – Volume I", Laxmi Publications, New Delhi, 2005
3. Jain R.K., "Engineering Metrology", Khanna Publishers, 2005
4. Mikell. P. Groover, Automation Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India Ltd., New Delhi, 1998.
5. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2007.

REFERENCES

1. Paul Degarma E, Black J.T. and Ronald A. Kosher, Materials and Processes, in Manufacturing Prentice – Prentice Hall of India.
2. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd.,
3. Milton C.Shaw, 'Metal Cutting Principles', Oxford University Press, Second edition,2005.
4. Rao, P.N. "Manufacturing Technology", Metal Cutting and Machine Tools, Tata McGraw–Hill, New Delhi, 2003.
5. Gupta S.C, "Engineering Metrology", Dhanpat rai Publications, 2005
6. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, (1994).
7. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.

E-REFERENCES

1.http://nptel.iitm.ac.in/courses

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO2	2	3	-	2	1	1	-	-	-	-	-	1	3	
CO3	2	3	-	2	1	1	-	-	1	-	-	1	3	
CO4	2	3	2	1	1	1	-	-	1	-	-	1	3	

CO5	2	3	-	2	1	1	-	-	-	-	-	1	3	
Tot	10	15	2	9	5	5			3			5	15	

1 - Low, 2 – Medium, 3- High

Semester	**VI**	
Course Name	**Operations Research**	
Course Code	**PUM605**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3 – 0 – 0– 3	**3:0:0**	**3–0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Explain*** the basic concepts of optimization and To F***ormulate*** and Solve linear programming problems.	C(Understand, Apply)
CO2	***Apply*** the concepts of transportation problem, assignment problem and travelling salesman problem Participate in the class discussion in the transportation model.	C(Apply) A(Respond to phenomena)
CO3	***Explain*** and demonstrate the basic concepts of PERT- CPM and their applications in product planning control.	C(Understand)
CO4	***Solve*** the Minimal Spanning Tree Problem, Shortest Route Problem, Maximal Flow Problem and Minimal Cost Capacitated Flow Problem**.** Reproduce the Network model.	C(Apply) P(Guided Response)
CO5	***Apply*** the concepts of Game theory to Find the solution and saddle point.	C(Apply, Remember)

COURSE CONTENT

UNIT I	**LINEAR MODELS**	**12 Hours**
	Basics of OR, Linear programming problems (L.P.P), Mathematical Formulation of L.P.P, Graphical method, Simplex algorithm, Duality.	
UNIT II	**TRANSPORTATION MODELS**	**12 Hours**
	Transportation problem, Assignment problem, Travelling Salesman problem.	
UNIT III	**PROJECT SCHEDULING BY PERT-CPM**	**12 Hours**
	PERT-CPM, product planning control with PERT-CPM.	
UNIT IV	**NETWORK MODELS**	**12 Hours**
	Network definition, Minimal Spanning Tree Problem, Shortest Route Problem, Maximal Flow Problem, Minimal Cost Capacitated Flow Problem.	
UNIT V	**GAME THEORY**	**12 Hours**
	Introduction - competitive game - finite and infinite game - two person zero sum game - rectangular game - solution of game- saddle point, solution of a rectangular game with	

saddle point.

L = 45 Hours **Tutorial = 15 Hours** **Total = 60 Hours**

TEXT BOOKS

3. Kantiswaroop,Gupta P.K and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi, (2008).(Unit I,II,III & V)
4. R.Paneerselvam, Operations Research,PHI Learning Private Limited,NewDelhi,(2010)(Unit IV)

REFERENCE BOOKS

1.Hadley G, Linear Programming, Narosa publishing House, (1995).

2. Hadley G, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass, (1973).

3. Gupta R. K. "Linear Programming",Krishna Prakashan Media(P) Ltd. ,(2009).

E – REFERENCES

3. www.nptel.ac.in
4. Fundamentals of Operations Research, Advanced Operation Research Prof.G.Srinivasan, Department of Management Studies, Indian Institute of Technology, Madras.

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1			1		1		1	
CO2	3	1		1			1		1			
CO3	3	1		1			1		1			
CO4	3	1		1			1		1		1	
CO5	3	1		1			1		1			
Tot	15	5	0	5	0	0	5	0	5	0	2	0

1 - Low, 2 – Medium, 3- High

Semester	**VII**
Subject Name	**Project Work**
Subject Code	**PME702**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 6– 6	**0:6:0**	**0- 0– 12 – 12**

Course Outcome	**Domain/Level**
	C or P or A

Objectives:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

Semester	**V**
Subject Name	**REFRIGERATION AND AIR CONDITIONING**
Subject Code	**PME503A**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	To familiarize with the terminology associated with refrigeration systems and air conditioning	C (Understand),
CO2	To understand basic refrigeration processes	C (Understand)
CO3	To provide an overview of sorption system	C (Understand)
CO4	To understand the basics of psychrometry and practice of applied psychrometrics	C (Understand apply)
CO5	To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components	C (understand)

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**
	Classification of refrigeration systems	
UNIT II	**REFRIGERATION CYCLE**	**9 hrs**
	Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics -Ozone depletion and global warming issues-System components: Compressors, Condensers, Expansion devices and Evaporators-Performance matching of components of refrigeration systems	
UNIT III	**SORPTION REFRIGERATION**	**9 hrs**
	Advanced sorption refrigeration systems and their components.	
UNIT IV	**PSYCHROMETRY**	**9hrs**
	Review of Psychrometry and Air-conditioning processes-Comfort air conditioning and Cooling load calculations	
UNIT V	**REFRIGERATION SYSTEM COMPONENTS**	**9 hrs**
	Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils, Applications of AC systems	

L = 45 hrs Total = 45 hrs

TEXT BOOKS

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

REFERENCES

1. Roy.J Dossat, "Principles of Refrigeration", Pearson Education 1997.

2. Jordon and Prister, "Refrigeration and Air Conditioning", Prentice Hall of India PVT Ltd. New Delhi, 1985

3. Stoecker N.F and Jones, "Refrigeration and Air Conditioning", TMH, New Delhi, 1981.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	0	0	0	1	0	1	1	0	1	1		3
CO2	3	3	1	0	1	1	0	2	3	1	3	3		3
CO3	3	3	2	1	1	1	0	2	3	2	3	3		3
CO4	3	3	3	0	2	2	1	3	3	2	3	3		3
CO5	1	1	1	0	0	0	0	1	1	1	2	2		3
	13	**11**	**7**	**1**	**4**	**5**	**1**	**9**	**11**	**6**	**12**	**12**		**15**

1 - Low , 2 – Medium , 3- High

PME503B FLUID POWER ENGINEERING 3 0 0 3

FLUID POWER SYSTEMS AND FUNDAMENTALS 9

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols.

Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.

HYDRAULIC SYSTEM **6**

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps.

HYDRAULIC SYSTEM COMPONENTS **6**

Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

DESIGN OF HYDRAULIC CIRCUITS **9**

Construction of Control Components : Director control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram.

Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.

PNEUMATIC SYSTEMS AND COMPONENTS **8**

Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators.

Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

DESIGN OF PNEUMATIC CIRCUITS **7**

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves.Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

TOTAL : 45

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2000.

2. Majumdar S.R., “Oil Hydraulics”, Tata McGraw-Hill, 2000.

REFERENCES

1. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
2. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
3. Harry L. Stevart D.B, "Practical guide to fluid power", Taraoeala sons and Port Ltd. Broadey, 1976.
4. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
5. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

PME503C ENERGY CONVERSION SYSTEMS 3 0 0 3

Unit I STEAM POWER PLANT 15

Steam Power Plant: Solid, liquid and gaseous fuels, storage and preparation of fuels, fuel bed firing, combustion conditions, suspension firing, draft systems. Steam generators and their types, circulation principles, forced circulation boilers, water walls, mountings, and accessories, performance rating of boilers, Feed water conditioning, Fuel and ash handling equipment, dust collectors. Condenser cooling water system.

Unit II DIESEL POWER PLANT 15

Steam pipes, pipe fittings, lagging, air and gas ducts. Instrumentation and control of steam power plant. Diesel Power Plant: Equipment of diesel plants, field of applications, fuel - storage and handling, cooling systems.

Unit III NUCLEAR POWER PLANT 15

Nuclear Power Plant: Introduction to nuclear power, types of reactors, heat release rates, steam generation principles. Use of renewable energy - utilisation of solar, wind, tidal, geothermal resources. Hydroelectric power plants. Plant economy : Load curve, load factor, capacity factor, utilization factor etc. Investment cost, fixed and annual operating costs, unit cost, tariff, influence of station performance characteristics on costs. Selection and location of plants, comparative study of different plants.

References:

1. Power Plant Engineering by M.M. Elwakil, Tata McGraw Hill

2. Power Plant Engineering by P.K. Nag, Tata McGraw Hill

3. Power Plant Engineering by Domkundwar, Dhanpat Rai

PME503D METROLOGY AND MEASUREMENTS 3 0 0 3

Unit I CONCEPT OF MEASUREMENT 9

General concept – Generalised measurement system-Units and standards-measuring instruments- sensitivity, readability, range of accuracy, precision-static and dynamic response-repeatability-systematic and random errors-correction, calibration, interchangeability.

Unit II LINEAR AND ANGULAR MEASUREMENT 9

Definition of metrology-Linear measuring instruments: Vernier, micrometer, interval measurement, Slip gauges and classification, interferometery, optical flats, limit gauges-Comparators: Mechanical, pneumatic and electrical types, applications.

Angular measurements: -Sine bar, optical bevel protractor, angle Decker – Taper measurements.

Unit III FORM MEASUREMENT 9

Measurement of screw threads-Thread gauges, floating carriage micrometer-measurement of gears-tooth thickness-constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish, straightness, flatness and roundness measurements.

Unit IV LASER AND ADVANCES IN METROLOGY 9

Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements and machine tool metrology Coordinate measuring machine (CMM)-Constructional features – types, applications – digital devices- computer aided inspection.

Unit V MEASUREMENT OF POWER, FLOW AND TEMPERATURE RELATED PROPERTIES 9

Force, torque, power: -mechanical, pneumatic, hydraulic and electrical type-Flow measurement**:** Venturi, orifice, rotameter, pitot tube –Temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermister.

L: 45; T:0 ; Total: 45

TEXT BOOKS

1. Jain R.K., “Engineering Metrology”, Khanna Publishers, 1994
2. Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997

REFERENCES

1. Gupta S.C, “Engineering Metrology”, Dhanpat rai Publications, 1984
2. Jayal A.K, “Instrumentation and Mechanical Measurements”, Galgotia Publications 2000

3. Beckwith T.G, and N. Lewis Buck, “Mechanical Measurements”, Addison Wesley, 1991
4. Donald D Eckman, “Industrial Instrumentation”, Wiley Eastern, 1985.

PME504A NANOTECHNOLOGY 3 0 0 3

INTRODUCTION 6

Amorphous, crystalline, microcrystalline, quasi-crystalline and nano-crystalline materials. Historical development of nanomaterials – Issues in fabrication and characterization of nanomaterials

SYNTHESIS 9

Methods of production of Nanoparticles-Top down and Bottom up approach, Sol-gel synthesis, Inert gas condensation, High energy Ball milling, Plasma synthesis, Electro deposition and other techniques. Synthesis of Carbon Nanotubes – Solid carbon source based production techniques, Gaseous carbon source based production techniques - Growth mechanisms, Nano wires.

CHARACTERISATION TECHNIQUES 15

Scanning Probe Microscopy (SPM) – Scanning tunneling microscope, Transmission electron microscope, Scanning transmission electron microscope, Atomic force microscope, Scanning force microscopy, Electrostatic force microscopy , Dynamic force microscopy, Magnetic force microscopy, Scanning thermal microscopy, Peizo force microscopy, scanning capacitance microscopy, Nano indentation.

NANO FABRICATION AND MACHINING 9

LIGA, Ion beam etching, Molecular manufacturing techniques – Nano machining techniques –, Top/Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum materials.

APPLICATIONS 6

Applications in Mechanical, Electronics engineering industries – Use of nanomaterials in automobiles, aerospace, defense and medical applications – Metallic, polymeric, organic and ceramic nanomaterials.

TEXT BOOKS:

1. A.K. Bandyopadhyay, “ Nano Materials”, New Age International Publishers, New Delhi, 2007
2. Bharat Bhushan, “Handbook of Nanotechnology”, Springer, Germany, 2004.

REFERENCES:

1. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
2. Gregory Timp, "Nanotechnology", Springer, India, 2005
3. Ahmed Busnaina, "Nanomanufacturing Handbook", CRC Press, London, 2006.

Semester	**V**
Subject Name	**CAD / CAM**
Subject Code	**PME504B**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 - 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define*** Design Process, CAD, CAM and ***explain*** various stages of design and different types of design process *explain* the DOM concept CAM along with benefits of CAD	C(Remember, Understand)
CO2	***Classify*** and ***explain*** different graphical primitives and transformations systems along with complex geometry generation techniques. ***Classify*** and ***outline*** the various Data structure and management systems.	C(Remember, Understand)
CO3	***Define*** modeling and ***Classify*** different types of geometric models also ***outline*** different features of solid modeling packages	C(Remember, Understand)
CO4	***Explain*** and *contrast* NC CNC DNC also ***illustrate*** various tools ,devices and mechanisms used inside NC,CNC and DNC	C(Understand)
CO5	***List*** important NC Codes and ***create*** CNC code for simple CNC operations like turning and facing.	C(Remember, Create)

COURSE CONTENT

UNIT I	**DESIGN PROCESS**	**9 hrs**
	The design process - Morphology of design - Product cycle - Sequential and concurrent engineering - Role of computers - Computer Aided Engineering - Computer Aided Design - Design for Manufacturability – Computer Aided Manufacturing - Benefits of CAD.	

UNIT II	**INTERACTIVE COMPUTER GRAPHICS AND DATA STRUCTURES**	**9hrs**
	Creation of Graphic Primitives - Graphical input techniques - Display transformation in 2-D and 3-D – Viewing transformation - Clipping - hidden line elimination - Mathematical	

formulation for graphics - Curve generation techniques.

Model storages and Data structure - Information system. Engineering Data Management System. Hierarchical data structure. Network data structure - Relational data structure. Data storage, search and retrieval methods. Recent trends in Data Structures.

UNIT III SOLID MODELING 9 hrs

Geometric Modeling - Wireframe, Surface and Solid models - CSG and B-REP Techniques - Features of Solid Modeling Packages - Parametric and features - Interfaces to drafting, Design Analysis.

UNIT IV CONSTRUCTIONAL FEATURES OF CNC MACHINES 9 hrs

Numerical Control (DNC Systems). Design considerations of CNC machines for improving machining accuracy-Structural members-Slideways - Sides linear bearings - Ball screws - Spindle drives and feed drives - work holding devices and tool holding devices -Automatic Tool changers. Feedback devices - Principles of Operation-Machining Centres - Tooling for CNC machines.

UNIT V PART PROGRAMMING FOR CNC MACHINES 9 hrs

Numerical control codes - Standards - Manual Programming - Canned cycles and subroutines – Computer Assisted Programming, CAD / CAM approach to NC part programming - APT language, machining from 3D models. Validation of Programs.

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Ibrahim Zeid, " CAD - CAM Theory and Practice ", Tata McGraw-Hill Publishing Co. Ltd., 1998.
2. Sadhu Singh, " Computer Aided Design and Manufacturing ", Khanna Publishers, New Delhi, 1998.

REFERENCES

1. P.Radhakrishnan, “Computer Numerical Control ", New Central Book Agency, 1992.
2. Groover and Zimmers, " CAD / CAM : Computer Aided Design and Manufacturing Prentice Hall of India, New Delhi, 1994.

E-REFERENCES

1. http://nptel.iitm.ac.in/video.php?subjectId=112102101

2.http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Aided%20Design%20&%20ManufacturingI/index.htm

3.http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Aided%20Design%20&%20ManufacturingII/index.htm

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	1	3	1	1	2	2	3	3	
CO2	3	2	2	3	3	1	3	1	1	3	2	3	3	
CO3	3	2	2	3	2	1	3	1	1	3	2	3	3	
CO4	3	2	2	3	3	1	3	1	1	2	2	3	3	
CO5	3	3	2	3	2	1	3	1	2	3	3	3	3	
Total	15	11	10	15	12	5	15	5	6	13	11	15	15	

1 - Low, 2 – Medium, 3- High

PME504C TRIBOLOGY 3 0 0 3

INTRODUCTION 15

Introduction of tribology- introduction –regimes of lubrication-layout of the books-references-Nature of the rough surfaces-introduction-surface roughness –measurement of surface texture-Types of engineering surface –Mathematical representation surface features-analogue solutions-Discrete interval solutions of profile height- Statistical representation surface texture- Worked examples-closure- references

ELASTIC AND PLASTIC PROPERTIES 15

Elastic solids in normal contact-Introduction –deformation characteristics-Surface deformation in spherical contact-various contact geometries. -Line or circular footprint contacts-elliptical footprint contact- Worked examples-Onset of Yield-Cylindrical surfaces-spherical surfaces.-Nominally flat rough surfaces in contact-Idealized rough surfaces-Contact between real rough surfaces-Plasticity index-Fully Plastic surface contact- Worked examples-Contact between curved rough surfaces-Hertzian impact- closure-Appendices references-Dry friction and wear –Introduction- The basic mechanism of dry friction-Adhesion and deformation-adhesive friction-Influence of contaminant films-Deformation friction-Elastic rolling friction-Tractive rolling of an elastic cylinder-Creep ratio-Other examples of rolling friction-Thermal effects of a frictional temperature rise in concentrated contacts-wear of surfaces-Adhesive wear-Abrasive wear-Macroscopic sliding fatigue wear-corrosive wear-Fretting corrosion-closure-references

DIMENSIONAL ANALYSIS **15**

Lubricant properties-Introduction-Dynamic viscosity-Effect of temperature on viscosity-The American society for testing materials (A.S.T.M Chart)-viscosity index of lubricants (VI)-Polymer Thickened Oils-Blends of Oils-Grades of oil-Effect of pressure on viscosity-Lubricant density-Effect of shear rate on viscosity-Worked example-Closure

The Reynolds and energy equations-introduction-Reynolds equation-Dimensional Analysis-Derivation of Reynolds equation in three dimensions-Equilibrium of forces on a lubricant element-velocity distribution-mass continuity-Simplification of Reynolds Equation-Long bearing-long bearing approximation for rigid cylinders-line contact pressure distribution-long contact load-narrow bearing-Squeeze film bearings-Rolling contacts- The energy equation-Significance of terms in the energy equation-convected heat only.

REFERENCES:

1. Tribology - a System Approah to the Science and Technology of Friction, Lubrication and Wear by Horst Czichos, Elsevier Scientific Publishing Co.

2. Principles of Tribology by Halling J. (Editor), Macmillan, London.

3. Handbook of Tribology: Materials, Coatings and Surface Treatments by Bharath Bhooshan and B. K. Gupta, McGrawhill, New York.

PME504D **THERMAL ENGINEERING** **3 0 0 3**

Unit I **GAS POWER CYCLES** **9**

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure and air standard efficiency, Actual and theoretical PV diagram of four stroke engines, Actual and theoretical PV diagram of two stroke engines.

Unit II **INTERNAL COMBUSTION ENGINES** **9**

Classification of IC engine, IC engine components and functions. Valve timing diagram and port timing diagram. Comparison of two stroke and four stroke engines. Fuel supply systems, Ignition Systems, Performance calculation. Comparison of petrol & diesel engine. Fuels, Air-fuel ratio calculation, Knocking and Detonation. Lubrication system and cooling system. Exhaust gas analysis, pollution control norms.

Unit III **STEAM CYCLES, STEAM NOZZLES AND TURBINES** **9**

Rankine cycle, Modified Rankine cycle, Combined cycle, Bottoming and Topping cycles, Performance testing - Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and reaction principles, compounding,

velocity diagrams for simple and multistage turbines, speed regulations-governors and nozzle governors.

Unit IV AIR COMPRESSOR 9

Classification and working principle, work of compression with and without clearance. Volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressor and inter cooling – work of multistage air compressor, Rotary & Roto Dynamic types (Descriptive treatment only).

Unit V REFRIGERATION AND AIR-CONDITIONING 9

Vapour compression Refrigeration cycle – super heat, sub cooling, performance calculations. Working principle of vapour absorption system. Psychrometry, psychometric chart, Cooling load calculations. Concept of RSHF, GSHF, ESHF, performance analysis on simple systems.

L: 15;T:0; Total Hours:45

(Use of standard thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant property tables are permitted in the examination)

TEXT BOOKS

1. Rajput, "Thermal Engineering", S. Chand publishers, 2000**.**
2. Rudramoorthy R, "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2003.

REFERENCES

1. Kothandaraman.C.P., Domkundwar.S. and A.V.Domkundwar., "A course in Thermal Engineering", Dhanpat Rai & Sons, Fifth edition, 2002
2. Holman. J.P., "Thermodynamics", McGraw-Hill, 1985.
3. Rogers, Meyhew, "Engineering Thermodynamics", ELBS, 1992.
4. Arora.C.P., "Refrigeration and Air conditioning", TMH, 1994.
5. Sarkar B.K, " Thermal Engineering", Tata McGraw-Hill, 1998.

Semester	**VI**
Subject Name	**Automobile Engineering**
Subject Code	**PME602A**

L –T –P –C	**C:P:A**	**L –T –P –H**
3 - 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define and identifies*** the vehicle construction, types and specification of engines.	C(Knowledge) P(Perception)
CO2	***Differentiate and calibrates*** Ignition, Fuel Supply and Emission Control System.	C(Comprehension) P(Guided response)
CO3	***Categories and illustrate*** the various types of clutches and gear boxes.	C(Synthesis) P(Mechanism)
CO4	***Characterize and determine*** *the suspension, steering geometry and wheel specification.*	C(Knowledge) P(Perception)
CO5	***Assembles and Summarize the*** *Electrical systems and Dash board instrumentations.*	C(Evaluation) P(Guided response)

COURSE CONTENT

UNIT I	**Introduction to Vehicle structure**	**9 hrs**
	Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines-components, function and materials, variable valve timing (VVT).	
UNIT II	**Ignition, Fuel Supply and Emission Control System**	**9hrs**
	Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).	
UNIT III	**Transmission System**	**9 hrs**
	Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.	
UNIT IV	**Steering, Suspension and Braking System**	**9 hrs**
	Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.	
UNIT V	**Advances in Automobile Engineering**	**9 hrs**
	Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion &	

emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.
3. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
4. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

E-REFERENCES

1. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO2	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO3	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO4	3	3	2	3	3	1	3	1	1	2	2	3	2	
CO5	3	3	2	3	3	1	3	1	1	2	2	3	2	
Total	15	15	10	15	15	5	15	5	5	10	10	15	10	

1 - Low, 2 – Medium, 3- High

Semester	**VI**		
Subject Name	**Computational Fluid Dynamics**		
Subject Code	**PME602B**		
L –T –P –C		**C:P:A**	**L –T –P –H**
3- 0 – 0– 3		**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Define and apply*** governing equations of fluid dynamics ***Explain and apply*** turbulence kinetic energy equations, mathematical behavior of PDE on CFD	C(Remember, Understand , Apply)
CO2	***Define*** methods of deriving the discretization equations ***Explain and apply*** different methodologies for deriving solution	C(Understand , Apply)
CO3	***Define and explain*** steady / transient one dimensional conduction	C(Remember,

	equation. A***pply*** finite volume formulation for conduction problems.	Understand , Apply)
CO4	**Explain and Solve** steady one dimensional conduction and diffusion problems	C(Remember, Understand , Apply
CO5	**Solve** fluid flow field calculations using CFD models	C(Remember, Understand , Apply

COURSE CONTENT

UNIT I	**GOVERNING EQUATIONS AND BOUNDARY CONDITIONS**	**9 hrs**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent flow - Turbulence -Kinetic -Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

UNIT II	**DISCRETIZATION AND SOLUTION METHODOLOGIES**	**9 hrs**

Methods of Deriving the Discretization Equations - Taylor Series formulation – Finite difference method – Control volume Formulation – Spectral method.

Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

UNIT III	**HEAT CONDUCTION**	**9 hrs**

Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

UNIT IV	**CONVECTION AND DIFFUSION**	**9 hrs**

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.

UNIT V	**CALCULATION OF FLOW FIELD**	**9 hrs**

Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE algorithm and its variants. Turbulence models: mixing length model, Two equation (k-e) models.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Versteeg, H.K, and Malalasekera, W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Longman, 1998.

2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw-Hill Publishing Company Ltd., 1998.

REFERENCES

1. Patankar, S.V., “Numerical Heat Transfer and Fluid Flow”, McGraw-Hill, 1980. Ane-Books2004 Indian Edition.

2. Muralidhar, K and Sundarajan .T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 1995.3. Bose, T.K., “Numerical Fluid Dynamics”, Narosa publishing House, 1997.

4. Muralidhar, K and Biswas “Advanced Engineering Fluid Mechanics”, Narosa Publishing House, New Delhi, 1996.

5. Anderson, J.D., “Computational fluid dynamics – the basics with applications”, 1995.

E RESOURCES

http://nptel.iitm.ac.in

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	3	-	1	-	-	2	2	3	2	
CO2	3	1	-	2	3	-	1	-	-	2	2	3	2	
CO3	3	-	-	1	2	-	1	-	-	1	-	2	2	
CO4	2	-	-	1	2	-	1	-	-	1	-	1	2	
CO5	3	2	-	2	3	-	1	-	-	1	2	2	2	
TOT	14	4	-	6	13	-	5	-	-	7	6	11	10	

1 - Low , 2 – Medium , 3- High

Semester	**VI**
Subject Name	**Finite Element Analysis**
Subject Code	**PME602C**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Solve** problems by applying standard finite element techniques	C (Apply)
CO2	**Analyze** 1-D finite elements and to build the stiffness matrix..	C (Analyze)

CO3	**Examine** 2-D finite element continuum for structural applications	C (Analyze)
CO4	**Apply** axisymmetric formulation for specific applications.	C (Apply)
CO5	**Make use of** finite element principles in isoparametric applications.	C (Apply)

COURSE CONTENT

UNIT I	**Introduction**	**9 hrs**
	Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – RitzTechnique – Basic concepts of the Finite Element Method.	
UNIT II	**ONE-DIMENSIONAL PROBLEMS**	**9 hrs**
	One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.	
UNIT III	**TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS**	**9 hrs**
	Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors.Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.	
UNIT IV	**TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS**	**9 hrs**
	Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.	
UNIT V	**ISOPARAMETRIC FORMULATION**	**9 hrs**
	Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements– One and two dimensions – Serendipity elements – Numerical integration and application to planestress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems –Introduction to Analysis Software.	

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.
8. Energy Manager Training Manual , Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).

REFERENCES

5. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002

6. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of

Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.

7. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 2000

8. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons,2005 (Indian Reprint 2013)*

E-REFERENCES

2. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	-	2	-	1	-	1	-	1	1	2	
CO2	3	2	3	1	3	1	1	-	1	1	2	3	2	
CO3	3	2	3	1	3	1	1	-	1	1	2	3	2	
CO4	3	2	3	1	3	1	1	-	1	1	2	3	2	
CO5	3	2	3	1	3	1	1	-	1	1	2	3	2	
TOT	15	9	14	4	14	4	5	-	5	4	9	13	10	

1 - Low , 2 – Medium , 3- High

PME602D OPTIMUM UTILIZATION OF HEAT AND POWER 3 0 0 3

CONVENTIONAL POWER GENERATION 12

Steam power plant - Selection of site - Generated Layout - coal and Ash Handling -Steam Generating Plants - Feed Make Circuit - Cooling Towers - Turbine Governing -Hydro Power Plant-Selection of Site - Classification Layout Governing of Turbines -Nuclear Power Plants - Selection of Site - Classification Layout Governing of Turbines - Nuclear Power Plants - Selection of Site - Nuclear Fuels - Nuclear reactors - Nuclear disposal - Gas Turbine Plants.

NON CONVENTIONAL POWER GENERATION 9

Wind power generation - characteristics of wind power-design of windmills - Tidal power generation - Single and two-basin systems Turbines for tidal power - Solar power generation - Energy from biomass, biogas and waste

ECONOMICS OF POWER GENERATION 7

Daily load curves - load factor - diversity factor - load deviation curve - load management - number and size of generating unit, cost of electrical energy – tariff - power factor improvement

ELECTRICAL POWER TRANSMISSION 9

Online diagram of transmission - substation and distribution systems - comparison of systems (DC and AC) - EHVAC and HVDC transmission - layout of substations and bus bar arrangements - Equivalents circuit of short, medium and long lines -Transmission efficiency-regulation-reactive power - compensation-transmission - loss minimization

UTILISATION OF ELECTRICAL ENERGY 8

Selection of Electrical Drives - Electrical characteristics and mechanical considerations -size, rating and cost, Transformer characteristics – illumination - laws of illumination-polar curve - incandascent-fluoroscent and vapour lamps - Design of OLTC lighting Scheme of industry-electrical welding - energy efficient aspects of devices

REFERENCES:

1. C.L.Wadhwa, Generation Distribution and utilization of Electrical Energy, Wiley Eastern Ltd., India(1989)
2. V.A.Venikov and B.V. Put Yatin, Introduction of Energy Technology, Electric power Engineering, MIR Publishers, Moscow(1984)
3. M.L.Soni,P.VGupta and V.S.A.Bhatnagar, Course in Electrical Power, Dhanbat Rai & Sons, NewDelhi(1983)
4. J.W.Twidell and A.D.Weir, Renewable Energy Sources, ELBS Edition(1986)
5. A.J.Wood and B.F. Wallenberg(1986):Power Generation, Operation and Control,2nd Edition, JohnWiley &Sons, Newyork
6. E.Khan(1988):Electrical Utility Planning and Regulation, American Council for an Energy Efficient Economy, Washington *D.C*

PME603A AUTOMATION AND CONTROL ENGINEERING 3 0 0 3

AUTOMATION 9

Types of production – Functions – Automation strategies – Production economics – Costs in manufacturing – Break-even analysis.

AUTOMATED FLOW LINES 6

Transfer mechanism - Buffer storage – Analysis of transfer lines - Automated assembly systems.

NUMERICAL CONTROL AND ROBOTICS 8

NC-CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications – End effectors – Sensors - Robot cell design – CAD/CAM.

AUTOMATED HANDLING AND STORAGE 7

Automated material handling systems – AS/RS – carousel storage – Automatic data capture – bar code technology

MANUFACTURING SUPPORT SYSTEMS 8

Product design and CAD, CAD/CAM and CIM, Computer aided process planning- variant and generative approaches, Concurrent engineering and design for manufacture, Lean production, Agile manufacturing.

REFERENCES:

1. Mikell P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing" PHI, 2003.
2. Weatherall, "Computer Integrated Manufacturing – A total company strategy", 2nd edition, 1995.

PME603B MODERN MANUFACTURING TECHNOLOGY, JIT, AMT 3 0 0 3

FUNDAMENTAL OF MANUFACTURING AND AUTOMATION 15

Manufacturing operations and automation strategies; Hard and soft automation. Transfer systems, automated flow lines, feeders, assembly and line balancing. Adaptive control, Manual part programming through simple examples; computer assisted part programming. Automated storage and materials handling systems, Automated materials handling (including AGV), storage and retrieval systems; Robots and its applications in manufacturing.

LEAN MANUFACTURING AND SIX SIGMA 15

Objectives of lean manufacturing-key principles and implications of lean manufacturing-traditional Vs lean manufacturing. Six sigma**:** Introduction- definition-methodology- impact of implementation of six sigma-DMAIC method-roles and responsibilities –leaders, champion, black belt, green belts.

INTRODUCTION TO JUST IN TIME MANUFACTURING AND AGILE MANUFACTURING 15

Introduction - elements of JIT – uniform production rate - pull versus push method- Kanban system - small lot size - quick, inexpensive set-up - continuous improvement. Optimized production technology. Introduction –elements of AMT-objectives of AMT.

REFERENCES:

1. Automation, Production Systems, & CIM by Grover; Prentice Hall 2. CAD CAM by C. McMahon and J. Browne; published by Addison-Wesley.

2. Agile Manufacturing by A. Gunsekaran; Elsevier

3. Computer Integrated Manufacturing and Engineering by V. Rembold, B. O. Nanji and A. Storr; Addin-Wesley.

4. De Feo J A and Barnard W W, “Six Sigma: Breaktrough and Beyond”, Tata McGraw-Hill, New Delhi, 2005.

5. Modern Production/ Operations Management, E. S. Buffa and R. K. Sarin, John Wiley International, 1994.

6. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, JohnWiley and Sons Inc., 2003.

7. Michael L George, David T Rowlands, Bill Kastle, “What is Lean Six Sigma”, McGraw-Hill, New York, 2004.

8. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.

Semester	**VI**	
Subject Name	**Reliability Engineering**	
Subject Code	**PME603C**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3-0– 0–3	**2.5:0.25:0.25**	**3- 0– 0 –3**

Course Outcome		**Domain/Level C or P or A**
CO1	**Classify** the Reliability and **uses** Failure data, failure modes, and reliability in terms of hazard rate and failure density function;Hazard models and bath tub curve; applicability of Weibull distribution	C(Understanding) A(Receiving)
CO2	**Make use of** Maintenance - its role and scope in total organisational context basic guidelines for design of organisation structure for **follows** maintanence; Centralised vs decentralised maintenance;	C(Apply) A(Valuing)
CO3	**Examine** the corrective, planned, preventive and predictive maintenance; opportunistic maintenance; Measurement of maintenance work **Identifies** the, Reliability and Human Engineering , Reliability Management	C(Analyze) A(Organization)
CO4	**Analysis** the Maintenance Theory –Inspection and **verify** the Failure Diagnosis Markov Maintenance Process	C(Analyze)

		A(Valuing, Set)
CO5	**Recall** the Basic laws of probability, Conditional probability, Random variable, sample distribution, statistical hypothesis, statistical tests of significance, correlation, regression **compare** the ANNOVA theory and SWOT	C(Remembering) A(Organization)

COURSE CONTENT

UNIT I	**Reliability: Definition and basic concepts**	**9 hrs**

Reliability: Definition and basic concepts; Failure data, failure modes, and reliability in terms of hazard rate and failure density function;Hazard models and bath tub curve; applicability of Weibull distribution. Reliability calculations for series, parallel and parallel-series systems; Reliability calculations for maintained and stand-by systems.

UNIT II	**Maintenance and Role of reliability**	**9 hrs**

Maintenance - its role and scope in total organisational context. Objectives and characteristics of maintenance; basic guidelines for design of organisation structure for maintanence; Centralised vs decentralised maintenance;

UNIT III	**Reliability Management and preventive maintenance**	**9 hrs**

Types of maintenance - corrective, planned, preventive and predictive maintenance; Factors affecting maintenance; opportunistic maintenance; Measurement of maintenance work; rating and allowances. Maintenance cost budgets. Maintenance planning and scheduling; MIS in maintenance; Measurement of maintenance effectiveness and maintenance audit. Applied Reliability -Reliability Testing, Reliability and Human Engineering , Reliability Management

UNIT IV	**Advanced reliability**	**9 hrs**

Advanced Maintenance Theory -Inspection(Surveillance) Policies -Failure Diagnosis Markov Maintenance Process

UNIT V	**Basic laws of probability ANNOVA concept**	**9 hrs**

Basic laws of probability, Conditional probability, Random variable, sample distribution, statistical hypothesis, statistical tests of significance, correlation, regression analysis, autocorrelation, ANOVA, concept of reliability, availability and maintainability (RAM), systems reliability, reliability improvement, design of maintenance systems, spare parts management, Decision Support System, SWOT.

L = 45 hrs T = 0 hrs P= 0 hrs Total = 45 hrs

TEXT BOOKS

2. Mechanical Reliability Engineering by ADS Carter, Macmilan

REFERENCES

1.Reliability Evaluation of Engineering Systems by Roy Billington and R.N. Allen, Pitman

2. Reliabilities for the Technologies by L.A.Doty, Industrial Press Inc.Kyung S. Park

E-REFERENCES

2. NPTEL; IITM/IITK Reliability theory

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	3	2	1	3	1	2	2	1	0	1	2	2	
CO2	1	3	1	3	2	1	1	1	3	0	2	1	2	
CO3	1	1	2	1	2	2	3	3	1	2	3	1	2	
CO4	0	1	2	1	2	2	2	1	1	1	3	2	2	
CO5	2	3	2	2	2	1	2	1	1	2	3	2	2	
TOT	4	11	9	8	11	7	10	8	7	5	12	8	10	

1 - Low , 2 – Medium , 3- High

Semester	**VI**
Subject Name	**Advanced I.C.ENGINES**
Subject Code	**PME603D**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	Understand working and performance of IC Engines through thermodynamic cycles.	C (Rem),
CO2	Outline emission formation mechanism of IC engines, its effects and the legislation standards.	C (Rem)
CO3	Understand working principles of instrumentation used for engine performance and emission parameters.	C (Rem)
CO4	Evaluate methods for improving the IC engine performance.	C (Understand)
CO5	Understand the latest developments in IC Engines and alternate fuels.	C (understand)

COURSE CONTENT

UNIT I	**GAS POWER CYCLES**	**9 hrs**

Review of ideal cycles; Details of fuel-air cycles.

UNIT II	COMBUSTION IN SI AND CI ENGINES	9hrs

Combustion in SI and CIengines, Combustion stages, Combustion chambers and Abnormal combustion.

UNIT III	FUEL SUPPLY SYSTEMS	9hrs

Fuel supply systemsin SI and CI engines, carburettors, Port fuel injection, Direct injection and Common rail injection.

UNIT IV	LUBRICATION SYSTEM	9hrs

Ignition system, Lubrication system and Cooling system.

UNIT V	ENGINE EMISSIONS AND CONTROL	9 hrs

Testing of IC engines. Engine emissionsand control. Advanced IC Engine concepts.

L = 45 hrs Total = 45 hr

TEXT BOOKS

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc. NY, 1973.
2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.
3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
4. Heldt P. M, "High Speed Combustion Engines", Oxford & IBH publishing Co. India, 1985.
5. Stockel M W, Stockel T S and Johanson C, "Auto Fundamentals", The Goodheart, Wilcox Co. Inc., Illinois, 1996.

E-REFERENCES

2. http://nptel.iitm.ac.in/courses

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	1	-	-	1		3
CO2	2	2	-	1	-	1		-	-	-	-	1		3
CO3	2	3	2	2	1	1	1	-	1	-	-	1		3
CO4	1	1	3	-	2	1	1	2	-	-	-	1		3
CO5	1	-	2	3	2	1	1	-	-	-	-	1		3
TOT	9	7	8	7	5	4	3	2	2			5		15

1 - Low , 2 – Medium , 3- High

Semester	VII

Subject Name	**POWER PLANT ENGINEERING**	
Subject Code	**PME701A**	
L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	What are the types of thermal power plants, systems operation and handling and cogeneration systems?	C(Rem), (Understend)
CO2	Describe gas turbine and combined cycle power plants systems components and operation	C (Rem) (Understand)
CO3	How nuclear energy conversion, nuclear power plant subsystems works and types of nuclear reactors.	C (Rem) (Understand)
CO4	What is the potential of exploiting renewable energy systems, and hydro power plant systems and components	C (Understand)
CO5	Extend energy economics and environmental issues of different power plants.	C (understand)

COURSE CONTENT

UNIT I	**THERMAL POWER PLANTS AND SYSTEMS HANDLING**	**12+0+0 hrs**

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

UNIT II	**GAS TURBINE POWER PLANTS AND COMBINED CYCLE SYSTEMS**	**9+0+0 hrs**

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

UNIT III	**NUCLEAR ENERGY POWER PLANTS**	**9+0+0 hrs**

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

UNIT IV	**HYDROPOWER PLANT AND RENEWABLE ENERGY SYSTEMS**	**6+0+0 hrs**

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

UNIT V	**ENERGY ECONOMICSAND ENVIRONMENTAL ISSUES**	**9+0+0 hrs**

Energy, economic and environmental issues, power tariffs, load distribution parameters,

load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

L = 45 hrs T = 0 hrs P=0hrs Total = 45 hrs

TEXT BOOKS

1. Power plant engineering by Arora and Domkudwar,Dhanpati Rai Publications ,2016
2. Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2017.
3. G.D.Rai, "Non conventional energy sources", Khanna Publishers, 1995.

REFERENCES

1. K.K. Ramalingam, "Power Plant Engineering", Scitech Publications, 2002.

2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010. .

E-REFERENCES

2. www. nptel.ac.in/courses/108105058/8

3. www.nptelvideos.in/2012/11/energy-resources-and-technology.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**-**	**-**	**3**	**1**	**2**	**-**	**-**	**2**	**-**	**-**	**1**		**3**
CO2	**3**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**		**3**
CO3	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**-**		**3**
CO4	**3**	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**2**	**-**	**1**	**1**		**3**
CO5	**3**	**-**	**-**	**1**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**		**3**
	13			**9**	**9**	**8**			**7**		**1**	**3**		**15**

1 - Low, 2 – Medium, 3- High

Semester	**VII**
Subject Name	**Mathematical Modelling and Simulation**
Subject Code	**PME701B**

L –T –P –C	**C:P:A**	**L –T –P –H**
3- 0 – 0– 3	**3:0:0**	**3- 0– 0– 3**

Course Outcome		**Domain/Level C or P or A**
CO1	*Define* system and *Classify* different aspects of systems also *Model* different types of mechanical systems	C(Remember, Understand , Apply)

CO2	*Define* random number *Model* different degrees of freedom systems also *compile* code for different types of random numbers	C(Understand , Apply)
CO3	*Explain* Problem simulation using different methods and *Classify* different types of simulation tools *Model* systems using different representational tools *solve* for typical simulation problem	C(Remember, Understand , Apply)
CO4	*Classify* different types of simulation languages available also able to *select* suitable simulation languages for different simulation problem also *demonstrate* expertise on any one simulation language	C(Remember, Understand , Apply
CO5	*Interpret* development of simulation models *Classify* simulation models *Explain* different types of systems *develop* simulation code for real-time problem *solve* the problem using simulation tools	C(Remember, Understand , Apply

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 hrs**

Systems, modeling, general systems theory, concept of simulation, simulation as a decision making tool, types of simulation.

UNIT II	**RANDOM NUMBERS AND VARIATES**	**9 hrs**

Pseudo random numbers, methods of generating random variates, testing of random numbers and variants.

UNIT III	**DESIGN OF SIMULATION EXPERIMENTS**	**9 hrs**

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation validation.

UNIT IV	**SIMULATION LANGUAGES**	**9 hrs**

Comparison and selection of simulation languages, study of any one simulation language.

UNIT V	**CASE STUDIES / MINI PROJECT**	**9 hrs**

Development of simulation models using the simulation language studied for systems like, queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network.

L = 45 hrs Total = 45 hr

TEXT BOOKS AND REFERENCES

1.Jerry Banks and John S.Carson, Barry L Nelson, David M.Nicol, P.Shahabudeen,
2.Discrete event system simulation, Pearson Education, 2007.
3.Law A.M, Simulation Modelling and Analysis, Tata Mc Graw Hill,2008
4.Thomas J.Schriber, Simulation using GPSS, John Wiley, 1991.
Kelton, W. David, Simulation with Arena ,McGraw-Hill,2006

E RESOURCES

3. http://www.intechopen.com
4. https://www.scilab.org/resources/documentation/tutorials

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	2	1	2	2	3	2	
CO2	3	3	2	3	3	1	3	2	1	2	2	3	2	
CO3	3	3	2	3	3	1	3	2	1	2	2	3	2	
CO4	3	3	2	3	3	1	3	2	1	2	3	3	2	
CO5	3	3	2	3	3	1	3	2	1	2	3	3	2	
TOT	15	15	10	15	15	5	15	10	5	10	12	15	10	

1 - Low, 2 – Medium, 3- High

PME701C ENGINEERING ECONOMICS AND COST ANALYSIS 3 0 0 3

INTRODUCTION TO ECONOMICS 8

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

CASH FLOW 9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods

VALUE ENGINEERING *12*

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor,

Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

DEPRECIATION 7

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

TOTAL : 45

TEXT BOOKS

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.

2. Lawrence and Mile., "Value Engineering"

REFERENCES

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, NewYork, 1984
4. Grant.E.L., Ireson.W.G., and Leavenworth, R.S, "Principles of Engineering Economy", Ronald Press, New York,1976.
5. Smith, G.W., "Engineering Economy", Lowa State Press, Iowa, 1973.

PME701D MATERIALS MANAGEMENT AND INDUSTRIAL ENGINEERING

3 0 0 3

MATERIALS MANAGEMENT **15**

Materials Management, Purchase and Stores Management: Inventory control, Material Handling. Industrial Management: Principles and functions of Management: Management Concepts, Leadership and decision making,

HUMAN RESOURCES **15**

Human resources: personnel management, industrial legislation and relations, industrial psychology, manpower planning, training and development, health, safety, welfare, remuneration and incentive schemes.

Financial Management, Sales and Marketing Management. Cost Accounting and Control, Budget and Budgetary control.

Plant Layout **15**

Plant Layout, Location and Line Balancing, Process Planning and Group Technology, Production planning and control

Text Book

1. Productions and Operations Management by A.Muhlemann, J.Oakland and K.Lockyer, Macmillan.

2. Industrial Engineering and Management by O.P.KHANNA

References :

1. Production Systems: Planning, Analysis and Control by J.L.Riggs, 3rd ed., Wiley.

2. Quality Control and Introduction statistics- Duncan A.J.