Scheme & Syllabi

for

B.Tech.
(Mechanical Engineering)

(w.e.f. 2018-2019)

Department of Mechanical Engineering

Guru Jambheshwar University of Science & Technology,
Hisar-125001

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Vision and Mission of the Department

Vision
To build a world-class department by excelling in research, design and development areas through sustainable growth, in order to produce the best globally competitive engineers.

Mission
• To develop mechanical engineering graduates and post graduates, for a successful career in industry and academia around the world through effective teaching learning and training. • To develop the capability of graduates and postgraduates for creating innovative products/systems in order to improve the quality of life. • To establish an environment which encourages and builds an exemplary professional having ability to solve societal problems through engineering and professional skills.

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Program Educational Objectives (PEOs)

PEO1	Apply technical skill and professional knowledge in engineering practices to face industrial challenges around the world.
PEO2	To prepare the students to lead a successful career in industries or to pursue higher studies or to support entrepreneurial endeavors.
PEO3	Inculcate effective team work, ethics, and leadership with ability to solve societal problems.

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Programme Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify**,** formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage:** Create**,** select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
P10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society. Some of them are, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Lifelong Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Programme Specific Outcomes (PSOs)

PSO1	To prepare the students to understand mechanical systems, components and processes to address technical and engineering challenges.
PSO2	To empower the student to build up career in industry or pursue higher studies in mechanical/interdisciplinary program.
PSO 3	To enhance the skills of the students with the ability to implement the scientific concepts for betterment of the society considering ethical, environmental and social values.

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Template for Course Outcomes with Revised Blooms Taxonomy (RBT's)

S. No.	Course Outcomes	RBT Level
CO1	Students will be able to …….	**(LOTS) Remembering**
CO2	Students will be able to …….	**(LOTS) Understanding**
CO3	Students will be able to …….	**(LOTS) Applying**
CO4	Students will be able to …….	**(HOTS) Analyzing**
CO5	Students will be able to …….	**(HOTS) Evaluating**
CO6	Students will be able to …….	**(HOTS) Creating**

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Structure of B.Tech. (Mechanical Engineering) Programme

Credit Score

(i) Category wise

S. No.	Category	Category Code	Credits
1	Humanities and Social Sciences including Management Courses	HSMC	07
2	Basic Science Courses	BSC	25
3	Engineering Science Courses	ESC	22
4	Professional Core Courses	PCC	70
5	Professional Elective Courses	PEC	15
6	Open Elective	OE	09
7	Project work, Seminar and Internship in Industry	PROJ	12
8	Mandatory Courses	MC	00
Total			**160**

(ii) Semester wise

Semester	Credits
1st	17.5
2nd	20.5
3rd	21.0
4th	20.0
5th	23.0
6th	21.0
7th	18.0
8th	19.0
Total	**160.0**

Course list Category Wise

(i) Humanities and Social Sciences including Management Courses (HSMC)

Sr. No.	Semester	Course Title	Course Credits
1.	2nd	English (Theory and Lab)	3.0
2.	5th	Fundamental of Management for Engineers (Theory)	2.0
3.	6th	Economics for Engineers (Theory)	2.0
Total Credits			**7.0**

(ii) Basic Science Courses (BSC)

Sr. No.	Semester	Course Title	Course Credits
1.	1st	Physics: Introduction to Electromagnetic Theory (Theory and Lab)	5.5
2.		Maths –I (Theory)	4.0
3.	2nd	Chemistry (Theory and Lab)	5.5
4.		Maths –II (Theory)	4.0
5.	3rd	Maths-III (Theory)	3.0
6.	4th	Numerical Methods (Theory and Lab)	3.0
Total Credits			**25.0**

(iii) Engineering Science Courses (ESC)

Sr. No.	Semester	Course Title	Course Credits
1.	1st	Basic Electrical Engineering (Theory and Lab)	5.0
2.		Workshop/Manufacturing Practices (Theory and Lab)	3.0
3.	2nd	Programming for Problem Solving (Theory and Lab)	5.0
4.		Engineering Graphics & Design (Lab)	3.0
5.	3rd	Basics of Electronics Engineering (Theory)	3.0
6.		Engineering Mechanics (Theory)	3.0
Total Credits			**22.0**

(iv) Professional Core Courses (PCC)

Sr. No.	Semester	Course Title	Course Credits
1.	3rd	Mechanics of Solids-I (Theory and Lab)	5.0
2.		Production Technology (Theory and Lab)	4.0
3.		Thermodynamics (Theory)	3.0
4.	4th	Material Science (Theory and Lab)	4.0
5.		Fluid Mechanics (Theory and Lab)	5.0
6.		Steam and Power Generation (Theory)	3.0
7.		Mechanics of Solids-II (Theory)	4.0
8.	5th	Kinematics of Machines (Theory and Lab)	4.0
9.		Hydraulic Machines (Theory and Lab)	5.0
10.		Internal Combustion Engines and Gas Turbines (Theory and Lab)	4.0
11.		Design of Machine Elements (Theory)	4.0
12.	6th	Dynamics of Machines (Theory and Lab)	4.0
13.		Automobile Engineering (Theory and Lab)	4.0
14.		Heat Transfer (Theory and Lab)	5.0
15.	7th	Refrigeration and Air-Conditioning (Theory and Lab)	5.0
16.	8th	Mechanical Vibrations (Theory)	3.0
17.		Computer Aided Design and Manufacturing (Theory and Lab)	4.0
Total Credits			**70.0**

(v) Professional Elective Courses (PEC)

Sr. No.	Semester	Course Title	Course Credits
		Professional Elective-I	**3.0**
1.	6th	Operation Research (Theory)	
2.		Work Study (Theory)	
3.		Total Quality Control (Theory)	
4.		Production Management (Theory)	
5.		Industrial Engineering (Theory)	
		Professional Elective-II	**3.0**
6.	7th	Automation in Manufacturing (Theory)	
7.		Advanced Welding (Theory)	
8.		Tool Engineering (Theory)	
9.		Modern Manufacturing Processes (Theory)	
		Professional Elective-III	**3.0**
10.	7th	Introduction to Tribology (Theory)	
11.		CNC Technology (Theory)	
12.		Reverse Engineering (Theory)	
13.		Product Design and Development (Theory)	
		Professional Elective-IV	**3.0**
14.	8th	Robotics (Theory)	
15.		Mechatronics (Theory)	
16.		Automatic Control (Theory)	
17.		Flexible Manufacturing Systems (Theory)	
18.		Rapid Prototyping (Theory)	
		Professional Elective-V	**3.0**
19.	8th	Power Plant Engineering (Theory)	
20.		Solar Energy Engineering (Theory)	
21.		Design of Heat Exchangers (Theory)	
22.		Turbo Machinery (Theory)	
23.		Computational Fluid Dynamics (Theory)	
Total Credits			**15.0**

(vi) Open Elective (OE)

Sr. No.	Semester	Course Title	Course Credits
		Open Elective-I	**3.0**
1.	5th	Fundamentals of Printing (Theory)	
2.		Information and Cyber Security (Theory)	
3.		Principles of Digital Electronics (Theory)	
4.		Processing and Preservation of Foods (Theory)	
5.		Introduction to Civil Engineering (Theory)	
6.		Utilization of Electrical Energy (Theory)	
		Open Elective-II	**3.0**
7.	6th	Graphics Design Fundamentals (Theory)	
8.		Introduction to Soft Computing (Theory)	
9.		Fundamentals of Communication Systems (Theory)	
10.		Food Safety, Quality and Regulations (Theory)	
11.		Introduction to Fluid Mechanics (Theory)	
12.		Renewable Energy Resources (Theory)	
		Open Elective-III	**3.0**
13.	7th	Fundamentals of Packaging (Theory)	
14.		Statistical Computing (Theory)	
15.		Introduction to MATLAB and Simulink (Theory)	
16.		Instrumental Analysis of Foods (Theory)	
17.		Environmental Engineering (Theory)	
18.		Energy Management and Audit (Theory)	
Total Credits			**9.0**

(vii) Project work, Seminar and Internship in Industry (PROJ)

Sr. No.	Semester	Course Title	Course Credits
1.	4th	Skill and Innovation Lab	1.0
2.	5th	Industrial Training Presentation-I	1.0
3.	7th	Minor Project	3.0
4.		Industrial Training Presentation-II	1.0
5.	8th	Major Project	5.0
6.		Seminar	1.0
Total Credits			**12.0**

(viii)Mandatory Courses (MC)

Sr. No.	Semester	Course Title	Course Credits
1.	1st	Induction training	0.0
2.	2nd	Environmental Sciences (Theory)	0.0
3.	3rd	Indian Constitution (Theory)	0.0
4.	4th	Essence of Indian Traditional Knowledge (Theory)	0.0
5.	5th	Technical Presentation (Lab)	0.0
6.	6th	Entrepreneurship (Theory)	0.0
7.	7th	General Proficiency (Lab)	0.0
Total Credits			**0.0**

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

I- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1	Basic Science Courses	BSC101(I)-T	BSC101(I)-P	Physics: Introduction to Electromagnetic Theory	3	1	3	4.0	1.5	5.5
2	Basic Science Courses	BSC103-T	--	Maths –I	3	1	0	4.0	--	4.0
3	Engineering Science Courses	ESC101-T	ESC101-P	Basic Electrical Engineering	3	1	2	4.0	1.0	5.0
4	Engineering Science Courses	ESC104-T	ESC104-P	Workshop/ Manufacturing Practices	1	0	4	1.0	2.0	3.0
5	Mandatory Courses	MC 101		Induction Training	3 weeks			--	--	0.0
Total										17.5

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

II- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1	Basic Science Courses	BSC 102 -T	BSC 102 -P	Chemistry	3	1	3	4.0	1.5	5.5
2	Basic Science Courses	BSC104-T	--	Maths –II	3	1	0	4.0	--	4.0
3	Engineering Science Courses	ESC103 -T	ESC103 -P	Programming for Problem Solving	3	0	4	3.0	2.0	5.0
4	Engineering Science Courses	--	ESC102-P	Engineering Graphics & Design	1	0	4	--	3.0	3.0
5	Humanities & Social Sciences including Management Courses	HSMC101-T	HSMC101-P	English	2	0	2	2.0	1.0	3.0
6	Mandatory Courses	MC102-T	--	Environmental Sciences	3	0	0	0.0	--	0.0
Total										20.5

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

III- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Basic Science Courses	BSC201-T	--	Maths-III	3	0	0	3.0	--	3.0
2.	Engineering Science Courses	ESC-ECE201-T	--	Basics of Electronics Engineering	3	0	0	3.0	--	3.0
3.	Engineering Science Courses	ESC-ME201-T	--	Engineering Mechanics	3	0	0	3.0	--	3.0
4.	Professional Core Courses	PCC-ME201-T	PCC-ME201-P	Mechanics of Solids-I	3	1	2	4.0	1.0	5.0
5.	Professional Core Courses	PCC-ME202-T	PCC-ME202-P	Production Technology	2	0	4	2.0	2.0	4.0
6.	Professional Core Courses	PCC-ME203-T	--	Thermodynamics	3	0	0	3.0	--	3.0
7.	Mandatory Courses	MC103-T	--	Indian Constitution	3	0	0	0.0	--	0.0
					20	1	6			
Total credits										21

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

IV- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Basic Science Courses	BSC202-T	BSC202-P	Numerical Methods	2	0	2	2.0	1.0	3.0
2.	Professional Core Courses	PCC-ME204-T	PCC-ME204-P	Material Science	3	0	2	3.0	1.0	4.0
3	Professional Core Courses	PCC-ME205-T	PCC-ME205-P	Fluid Mechanics	3	1	2	4.0	1.0	5.0
4	Professional Core Courses	PCC-ME206-T	--	Steam and Power Generation	3	0	0	3.0	--	3.0
5	Professional Core Courses	PCC-ME207-T	--	Mechanics of Solids-II	3	1	0	4.0	--	4.0
6	Project work, Seminar and Internship in Industry	--	PROJ-ME201-P	Skill and Innovation Lab	0	0	2	--	1.0	1.0
7.	Mandatory Courses	MC104-T	--	Essence of Indian Traditional Knowledge	3	0	0	0.0	--	0.0
					17	2	8			
Total credits										20.0

Note- At the end of the IV-semester each student would undergo 4-6 weeks practical training in an industry/research laboratory.

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

V- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OE (refer to list)#	--	Open Elective-I	3	0	0	3.0	--	3.0
2.	Humanities & Social Sciences including Management Courses	HSMC302-T	--	Fundamental of Management for Engineers	2	0	0	2.0	--	2.0
3.	Professional Core Courses	PCC-ME301-T	PCC-ME301-P	Kinematics of Machines	3	0	2	3.0	1.0	4.0
4.	Professional Core Courses	PCC-ME302-T	PCC-ME302-P	Hydraulic Machines	3	1	2	4.0	1.0	5.0
5.	Professional Core Courses	PCC-ME303-T	PCC-ME303-P	Internal Combustion Engines and Gas Turbines	3	0	2	3.0	1.0	4.0
6.	Professional Core Courses	PCC-ME304-T	--	Design of Machine Elements	2	2	0	4.0	--	4.0
7.	Project work, Seminar and Internship in Industry	--	PROJ-ME301-P	Industrial Training Presentation-I	0	0	2	--	1.0	1.0
8.	Mandatory Courses	--	MC-ME301-P	Technical Presentation	0	0	2	--	0.0	0.0
					16	3	10			
Total credits										23.0

#Open Elective -I	
Course Code	**Course Name**
OE-PTG391-T	Fundamentals of Printing
OE-CSE391-T	Information and Cyber Security
OE-ECE391-T	Principles of Digital Electronics
OE-FT391-T	Processing and Preservation of Foods
OE-CE391-T	Introduction to Civil Engineering
OE-EE391-T	Utilization of Electrical Energy

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

VI- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OE (refer to list)##	--	Open Elective-II	3	0	0	3.0	--	3.0
2.	Professional Elective Courses	PEC (refer to list)*	--	Professional Elective -I	3	0	0	3.0	--	3.0
3.	Humanities & Social Sciences including Management Courses	HSMC301-T	--	Economics for Engineers	2	0	0	2.0	--	2.0
4.	Professional Core Courses	PCC-ME305-T	PCC-ME305-P	Dynamics of Machines	3	0	2	3.0	1.0	4.0
5.	Professional Core Courses	PCC-ME306-T	PCC-ME306-P	Automobile Engineering	3	0	2	3.0	1.0	4.0
6.	Professional Core Courses	PCC-ME307-T	PCC-ME307-P	Heat Transfer	3	1	2	4.0	1.0	5.0
7.	Mandatory Courses	MC-ME302-T	--	Entrepreneurship	3	0	0	0.0	--	0.0
					20	1	6			
Total credits										21.0

Note- At the end of the VI-semester each student would undergo 4-6 weeks practical training in an industry/research laboratory.

##Open Elective –II	
Course Code	**Course Name**
OE-PTG392-T	Graphics Design Fundamentals
OE-CSE392-T	Introduction to Soft Computing
OE-ECE392-T	Fundamentals of Communication Systems
OE-FT392-T	Food Safety, Quality and Regulations
OE-CE392-T	Introduction to Fluid Mechanics
OE-EE392-T	Renewable Energy Resources

*Professional Elective -I	
Course Code	**Course Name**
PEC-ME351-T	Operation Research
PEC-ME352-T	Work Study
PEC-ME353-T	Total Quality Control
PEC-ME354-T	Production Management
PEC-ME355-T	Industrial Engineering

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

VII- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OE (refer to list)###	--	Open Elective-III	3	0	0	3.0	--	3.0
2.	Professional Elective Courses	PEC (refer to list)**	--	Professional Elective -II	3	0	0	3.0	--	3.0
3	Professional Elective Courses	PEC (refer to list)***	--	Professional Elective -III	3	0	0	3.0	--	3.0
4.	Professional Core Courses	PCC-ME401-T	PCC-ME401-P	Refrigeration and Air-Conditioning	3	1	2	4.0	1.0	5.0
5.	Project work, Seminar and Internship in Industry	--	PROJ-ME401-P	Minor project	0	0	6	--	3.0	3.0
6.	Project work, Seminar and Internship in Industry	--	PROJ-ME402-P	Industrial Training Presentation-II	0	0	2	--	1.0	1.0
7.	Mandatory Courses	--	MC-ME401-P	General Proficiency	0	0	2	--	0.0	0.0
					12	1	12			
Total credits										18.0

###Open Elective –III	
Course Code	**Course Name**
OE-PTG491-T	Fundamentals of Packaging
OE-CSE491-T	Statistical Computing
OE-ECE491-T	Introduction to MATLAB and Simulink
OE-FT491-T	Instrumental Analysis of Foods
OE-CE491-T	Environmental Engineering
OE-EE491-T	Energy Management and Audit

**Professional Elective -II	
Course Code	**Course Name**
PEC-ME451-T	Automation in Manufacturing
PEC-ME452-T	Advanced Welding
PEC-ME453-T	Tool Engineering
PEC-ME454-T	Modern Manufacturing Processes

***Professional Elective -III	
Course Code	**Course Name**
PEC-ME455-T	Introduction to Tribology
PEC-ME456-T	CNC Technology
PEC-ME457-T	Reverse Engineering
PEC-ME458-T	Product Design and Development

DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

VIII- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Professional Elective Courses	PEC (refer to list)****	--	Professional Elective -IV	3	0	0	3.0	--	3.0
2.	Professional Elective Courses	PEC (refer to list)*****	--	Professional Elective -V	3	0	0	3.0	--	3.0
3.	Professional Core Courses	PCC-ME402-T	--	Mechanical Vibrations	3	0	0	3.0	--	3.0
4.	Professional Core Courses	PCC-ME403-T	PCC-ME403-P	Computer Aided Design and Manufacturing	3	0	2	3.0	1.0	4.0
5.	Project Work, Seminar and Internship in Industry	--	PROJ-ME403-P	Major Project	0	0	10	--	5.0	5.0
6.	Project Work, Seminar and Internship in Industry	--	PROJ-ME404-P	Seminar	0	0	2	--	1.0	1.0
					12	0	14			
Total credits										19.0

****Professional Elective -IV	
Course Code	**Course Name**
PEC-ME459-T	Robotics
PEC-ME460-T	Mechatronics
PEC-ME461-T	Automatic Control
PEC-ME462-T	Flexible Manufacturing Systems
PEC-ME463-T	Rapid Prototyping

*****Professional Elective -V	
Course Code	**Course Name**
PEC-ME464-T	Power Plant Engineering
PEC-ME465-T	Solar Energy Engineering
PEC-ME466-T	Design of Heat Exchangers
PEC-ME467-T	Turbo Machinery
PEC-ME468-T	Computational Fluid Dynamics

3rd Semester

MATHS-III (THEORY)

General Course Information

Course Code: BSC201-T Course Category: Basic Science Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to define concepts and terminology of Fourier series and Fourier transforms, Functions of complex variables, Power Series and, Probability distributions and hypothesis testing.	L1
CO2	Students will be able to solve problems using Fourier transforms in domains like digital electronics and image processing	L2
CO3	Students will be able to apply mathematical principles to solve computational problems	L3
CO4	Students will be able to compare various probability distributions.	L4
CO5	Students will be able to select suitable hypothesis testing methods for given problems and interpret the respective outcomes	L5
CO6	Students will be able to integrate the knowledge of Fourier series and Fourier transforms, Functions of complex variables, Power Series and, Probability distributions and hypothesis testing for solving real world problems	L6

Course Contents

UNIT-I

Fourier Series and Fourier Transforms: Euler's formulae, conditions for a Fourier expansion, change of interval, Fourier expansion of odd and even functions, Fourier expansion of square wave, rectangular wave, saw-toothed wave, half and full rectified wave, half range sine and cosine series.

UNIT-II

Fourier integrals, Fourier transforms, Shifting theorem (both on time and frequency axes), Fourier transforms of derivatives, Fourier transforms of integrals, Convolution theorem, Fourier transform of Dirac delta function.

UNIT-III

Functions of Complex Variable: Definition, Exponential function, Trigonometric and Hyperbolic functions, Logarithmic functions. Limit and Continuity of a function, Differentiability and Analyticity. Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, polar form of the Cauchy-Riemann equations. Harmonic functions.

UNIT-IV

Complex integral, Cauchy Gaursat theorem (without proof), Cauchy integral formula (without proof), Power series, radius and circle of convergence, Taylor's Maclaurin's and Laurent's series. Zeroes and singularities of complex functions, Residues. Evaluation of real integrals using residues (around unit and semi-circle only).

Text and Reference Books

1. F. Kreyszig, Advanced Engineering Mathematics, 10th edition, Wiley, 2015.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th edition, 1965.
3. R.K. Jain, S.R.K. Iyenger. Advance Engineering. Mathematics, 4th edition, Narosa Publishing House, 2012.
4. Michael D. Greenberg, Advanced Engineering Mathematics,2nd edition, Pearson Education, 2002.
5. Johnson and Miller Probability and statistics for Engineers, 8th edition, Pearson Education India, 2015.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	--	--	--	--	--	--	--	--	--	--	--	--	2	2
CO2	2	2	2	2	--	--	--	--	--	--	--	--	--	2	2
CO3	2	2	2	2	--	--	--	--	--	--	--	--	--	2	3
CO4	3	3	2	3	--	--	--	--	--	--	--	--	--	2	3
CO5	3	3	2	3	--	--	--	--	--	--	--	--	--	2	3
CO6	3	3	2	3	--	--	--	--	--	--	--	--	--	2	3

1: (Slight/Low), 2 : (Moderate/Medium), 3: (Substantial/High)

BASICS OF ELECTRONICS ENGINEERING (THEORY)

General Course Information

Course Code: ESC-ECE201-T Course Category: Engineering Science Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to define the behavior of semiconductor devices.	L1
CO2	Students will be able to describe the current flow of a bipolar transistor in CB, CE and CC configurations.	L2
CO3	Students will be able to illustrate the biasing of transistors and FETs for amplifier applications.	L3
CO4	Students will be able to examine simple amplifier and oscillator circuits.	L4

Course Contents

UNIT-I

Semi-Conductors and Diodes: Introduction, Insulators, semiconductors and metals, Mobility and conductivity, Intrinsic and extrinsic semiconductors, Charge density, current components in semiconductors, Continuity equation, PN junction diode- Characteristics and analysis, Types of diodes- Zener, Photodiodes, LED. Rectifiers: Half wave rectifier, Full wave rectifier, bridge rectifier and their analysis, Series and shunt diode clippers, Clipping at two independent levels, Clamping operation, Clamping circuit, Basic regulator supply using zener diode.

UNIT-II

Transistors: Construction and characteristics of BJT, Transistor configuration: CB, CE, CC configuration, Transistor at low frequency, Small signal low frequency transistor model(h-parameters), Analysis of transistor amplifier using h-parameters, Transistor biasing and bias stabilization: Operating point, Stability factor, Analysis of fixed bias, collector to base bias, Emitter resistance bias circuit and self bias circuit, Bias compensation techniques.

UNIT-III

Field Effect Transistor: Construction and characteristics of JFET, JFET biasing circuit, JFET amplifier, MOSFET construction and characteristics.

UNIT-IV

Amplifiers and Oscillators: Classification of amplifiers, concept of feedback, Characteristics of feedback amplifiers, Single stage RC coupled amplifier, Oscillators, Criterion for oscillation, Types of oscillators: Hartley oscillator, Colpitt oscillator, RC-phase shift oscillator, Wein bridge oscillator.

Text and Reference Books

1. Integrated devices & Circuits by Millman & Halkias, McGraw Hill.
2. Electronics Devices and Circuit Theory by Robert L. Boylestad, Pearson.
3. Electronics Devices and Circuits-II by A.P.Godre & U.A. Bakshi.
4. Electronics Devices and Circuit by G.K. Mithal.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	2	--	--	--	--	2	--	2	1
CO2	3	--	2	2	--	1	2	1	1	--	1	2	--	2	1
CO3	2	3	2	1	--	1	2	--	1	1	1	2	--	2	1
CO4	2	3	3	3	3	2	1	1	2	1	1	2	--	2	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

ENGINEERING MECHANICS (THEORY)

General Course Information

Course Code: ESC-ME201-T Course Category: Engineering Science Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to describe scalar and vector techniques for analyzing forces in statically determinate structures.	L1
CO2	Students will be able to locate centroid, centre of gravity of different types of symmetrical and unsymmetrical sections.	L2
CO3	Students will be able to apply Newton's laws of Motions to solve real-world problems.	L3
CO4	Students will be able to examine the physical significance of moment of inertia e.g in railway, flyovers, Bridges, automobiles etc.	L4

Course Contents

UNIT-I

Review of Basic Force System: Laws of mechanics, Vector algebra review, Moment of a force about a point and axis, Couple and couple moment, Addition and subtraction of couples, Moment of a couple about a line, Resultant of a force system. Problems

Equilibrium of forces: Introduction, Lami's theorem, Methods for the equilibrium of coplanar forces, Analytical method for the equilibrium of coplanar forces, free body diagram, general equations of equilibrium, Tension in a string, Problems

UNIT-II

Truss and Frames: Types of frames, Types of stresses in frames (Tensile and compressive), Assumptions for forces in the members of a perfect frame, Analytical methods for the forces, Method of joints, Method of sections (or Method of moments), simply supported trusses, Problems

Centroid and centre of gravity: Definition, Centroid of regular shapes, Symmetrical sections, Unsymmetrical sections, Reference axis, Centre of gravity of solid bodies, Centroid and centre of gravity of hollow sections. Problems

UNIT-III

Moment of Inertia: Introduction and significance, Parallel axis theorem, Perpendicular axis theorem, Mass moment of inertia, Area moment of inertia of regular shapes: L-sections, T-sections, I-sections, Moment of inertia of unsymmetrical sections, hollow sections, Product of inertia, Properties of product of inertia, Principal axis. Problems

Particle dynamics- Rectilinear motion, Plane curvilinear motion (rectangular, path and polar coordinates), Newton's 2nd law (rectangular, path and polar coordinates), Work- kinetic energy, power, potential energy, Impulse-momentum (linear, angular), Impact (Direct and oblique). Problems

UNIT-IV

Virtual work: Introduction, Concept and principle of virtual work, Virtual displacements, Sign conventions, Applications of principle of virtual work on beams carrying point load, uniformly distributed load, Applications of virtual work on ladders. Problems

Friction: Introduction, Types of friction, Laws of friction, Equilibrium of a body on a rough horizontal plane and inclined plane, Equilibrium of a body on a rough inclined plane subjected to a force acting along the inclined plane, Equilibrium of a body on a rough inclined plane subjected to a force acting horizontally. Problems

Text and Reference Books

1. Irving H. Shames, Engineering Mechanics, 4th Edition, Prentice Hall
2. R.C. Hibbler (2017), Engineering Mechanics: Statics and Dynamics, Pearson Press.
3. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education
4. Reddy Vijaykumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics
5. Bansal R.K.(2015), A Text Book of Engineering Mechanics, Revised eighth edition, Laxmi Publications
6. Khurmi R.S., Engineering Mechanics, 20th revised edition, S. Chand & Co.
7. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	2	1	1	1	1	1	3	3	3	1
CO2	3	3	2	2	2	1	1	1	1	2	1	3	3	3	1
CO3	3	3	3	2	1	2	1	1	1	2	1	3	3	3	2
CO4	3	3	3	3	2	3	2	2	2	1	2	3	3	3	2
CO5	3	3	2	1	1	2	1	1	1	1	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MECHANICS OF SOLIDS-I (THEORY)

General Course Information

Course Code: PCC-ME201-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorials Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the concept of stress and strain at a point.	L1
CO2	Students will be able to illustrate 2D & 3D stress systems and determine principal stresses & planes and maximum shearing stresses & planes using analytical and graphical methods.	L2
CO3	Students will be able to draw Shear and Bending Moment diagrams for various beams subjected to different types of transverse loads.	L3
CO4	Students will be able to employ stress-strain relationship for axially loaded members, circular torsion members and members subjected to bending loads.	L4
CO5	Students will be able to design machine components subjected to combined torsion, bending and axial loads.	L5

Course Contents

UNIT-I

Simple stresses and strains: General equations of equilibrium, free body diagram, Types of stresses and strains, Hooks law, elastic constants & their relationships, concept of stress at a point, stress-strain diagrams, stresses and strains in compound bars under axial loading, stresses in composite systems, thermal stresses.

Complex stresses: Two and three dimensional stress systems, rectangular stress components, principal stresses and planes, Mohr's stress circle.

UNIT-II

Shear force and bending moment diagrams: Relation between the rate of loading, the shear force and the bending moment. SF & BM calculations & diagrams for (i) cantilevers (ii) simply supported beams with or without over-hang (iii) fixed beams under (i) concentrated loads, (ii) uniformly distributed loads over whole span or a part of it, (iii) combination of concentrated loads and uniformly distributed loads, (iv) uniform varying loads (v) application of moments.

UNIT-III

Centroid and Moment of Inertia: Centroid and MOI for different shaped beam cross sections**,** Parallel axes theorem, perpendicular axis theorem, principal axes**,** principal moments of inertia, product of inertia, ellipse of inertia, Properties of beam cross section**.**

Bending stresses in beams: Theory of simple bending, position of neutral axis, flitched beams. Unsymmetrical Bending, Slope of the neutral axis, stresses & deflections, shear center and the flexural axis.

Shearing stresses in beams: Introduction, shearing stress variation, variation of shear stress in beam cross section, shear stress distribution for typical sections.

UNIT-IV

Torsion: Torsion of circular shafts, comparison of Solid and hollow circular shafts, stepped shaft & composite circular shafts, statically indeterminate shafts, stresses in shafts under combined torsion, bending and axial loads.

Columns & Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Eulers, Rankine, Gordon's formula, Johnson's empirical formula for axial loading columns and their applications, eccentric compression of a short strut of rectangular & circular sections.

Text and Reference Books

1. Mechanics of Solid by Muubeen Abdul, Pearson Publications, India.
2. Engineering Mechanics of Solids by Popov E.P, Prentice Hall of India
3. Mechanics of Materials by Ferdinand P. Beer and E. Russel Johnston, Jr. Second Edition, McGraw Hill.
4. Solid Mechanics by Kazmi, Tata Mc Graw Hill.
5. Strength of Materials by G.H.Ryder, Macmillan, India.
6. Strength of Materials by D.S. Bedi, S. Chand & Co. Ltd.
7. Advanced Mechanics of Solids and Structures by N. Krishan Raju and D.R.Gururaje, Narosa Publishing House.
8. Strength of Materials by Andrew Pytel and Fredinand L. Singer, Int. Student Ed. Addison, Wesley Longman.
9. Strength of Materials by Sadhu Singh, Khanna Publishers, India.
10. Strength of Materials by Timoshenko S, East-West Press Pvt. Ltd., New Delhi.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	--	--	--	--	--	1	1	2	3	3	3	1
CO2	3	1	2	2	2	--	--	--	1	1	2	3	3	3	1
CO3	3	1	2	--	--	--	--	--	1	1	2	3	3	3	1
CO4	3	1	2	2	2	--	--	--	1	1	2	3	3	3	1
CO5	3	2	3	3	2	--	--	--	1	1	2	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MECHANICS OF SOLIDS-I (LAB)

General Course Information

Course Code: PCC-ME201-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to perform tensile test, compression test, bending test, shear test, hardness test, impact test and torsion test to determine mechanical properties such as strength, hardness, impact strength and toughness of ductile and brittle materials.	L1
CO2	Students will be able to predict the behaviour of ductile and brittle materials under different types of loading.	L2
CO3	Students will be able to Interpret the experimental results for material selection in engineering applications.	L3
CO4	Students will be able to compare the materials and utilize the appropriate materials in design considering engineering properties, sustainability, cost and weight.	L4

Lab Contents

1. To study the Universal Testing Machine (UTM) and perform the tensile test on the given specimen (Mild steel and Cast Iron).
2. To perform compression test on UTM on the given specimen (Mild steel and Cast Iron).
3. To perform bending tests on UTM on the given specimen.
4. To perform the shear test on UTM on the given specimen.
5. To perform the torsion test on the given specimen (Mild steel and Cast Iron).
6. To perform the Rockwell hardness test.
7. To perform the Brinell hardness test.
8. To perform the Vickers hardness test.
9. To perform the Impact tests (Izod & Charpy).
10. To perform the Erichsen cupping sheet metal test.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2	2	--	--	--	1	1	2	3	3	3	2
CO2	3	2	2	2	2	--	--	--	1	1	2	3	3	3	2
CO3	3	3	2	2	2	--	--	--	1	1	2	3	3	3	2
CO4	3	3	2	2	2	--	--	--	1	1	2	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

PRODUCTION TECHNOLOGY (THEORY)

General Course Information

Course Code: PCC-ME-202-T Course Category: Professional Core Course Course Credits: 2.0 Contact Hours: 2 hours/week (L: 2; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to define the various tools including machine tools, cutting tools and measuring tools, forces involved and their effect in cutting, work holding devices and methods required to manufacture different components.	L1
CO2	Students will be able to describe different types of tools, work holding devices and manufacturing methods along with their principles.	L2
CO3	Students will be able to solve different kind of problems related to tools and manufacturing methods selection.	L3
CO4	Students will be able to analyse various tools on the basis of economics of machining.	L4
CO5	Students will be able to select and design appropriate tool and method required to manufacture a particular component economically.	L5

Course Contents

UNIT-I

Theory of Metal Cutting: Introduction, Metal Cutting Machines and Tools, Elements of Metal Cutting, Geometry of Cutting Tools, Orthogonal and Oblique Cutting, Chip Formation, Chip Control, Forces Acting on a Single Point Tool, Measurement of Cutting Forces, Mechanics of Metal Cutting, Shear Plane, Chip Thickness Ratio, Shear Angle, Velocity Relationship in Orthogonal Cutting, Forces on the Chips, Stress and Strain in the chip, Work done during Metal Cutting, Heat Generation and Temperatures in Metal Cutting

Tool Wear and Machinability: Introduction, Tool Failure, Tool Wear, Tool Life, Cutting Speed, Feed and Depth of Cut, Tool Materials, Cutting Fluids, Power required for cutting, Machinability, Single Pass, Multi Pass and Multistage Machining

UNIT-II

Jigs and Fixtures: Introduction, Definitions and Concepts of Jig and Fixture, Advantages of Using Jigs and Fixtures, Elements of Jigs and Fixtures, Degree of Freedom, Types of Jigs, Types of Fixtures

Work Holding Devices: Basic Requirements of Work Holding Devices, Location: Principles, Methods and Devices, Clamping: Principles, Methods and Devices

UNIT-III

Manufacturing Methods: Turret Lathes and Their Characteristics, Classification of Gear Production Methods, Gear Generation, Indexing of Gears, Gear Hobbing, Gear Shaping, Gear Finishing Methods: Shaving, Burnishing, Grinding, Honing

Economics of Machining: Introduction, Choice of Feed, Economic Cutting Speed, Economics of Metal Removal, Minimum Cost/Component, Determination of Cutting Speed for Minimum Cost, Tool Life for Minimum Cost, Cutting Speed for Maximum Production, Tool Life for Maximum Production, Maximum Production Rate, Maximum Profit Rate

UNIT-IV

Non-Conventional Machining: Introduction, Classification of Non-Conventional Machining Processes, Process Selection, Ultrasonic Machining, Abrasive Jet Machining, Electro Chemical Machining, Electric Discharge Machining, Wire Electric Discharge Machining(WEDM), Electron Beam Machining, Laser Beam Machining

Metrology: Measurements, Linear and Angular Simple Measuring Instruments, Screw Gauge, Sine Bar, Auto-Collimator, Comparator-Mechanical, Electrical, Optical, Surface Finish and its Measurement

Text and Reference Books

1. Manufacturing science: Ghosh and Malik, E.W. Press
2. Principles of metal cutting: Sen and Bhattacharya, New Central Book.
3. Metal cutting principles: Shaw, MIT Press Cambridge
4. Manufacturing analysis: Cook, Adisson-Wesley
5. Modern machining processes: Pandey and Shan, Tata McGraw Hill Publications
6. Production Technology: P.C. Sharma, S. Chand Publication
7. Production Technology: O.P. Khanna, Dhanpat Rai Publication

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

PRODUCTION TECHNOLOGY (LAB)

General Course Information

Course Code: PCC-ME202-P Course Category: Professional Core Course Course Credits: 2.0 Mode: Practical Contact Hours: 04 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to define the various manufacturing processes like casting, machining and welding, and machine tools.	L1
CO2	Students will be able to describe different manufacturing processes and machine tools which can be used to manufacture a component.	L2
CO3	Students will be able to choose a particular type of method required to manufacture a particular component.	L3
CO4	Students will be able to experiment on various machine tools for components manufacturing.	L4
CO5	Students will be able to judge and design appropriate manufacturing processes and machine tool required to manufacture of a particular component.	L5

Lab Contents

1. To make a pattern for a given casting with all the necessary allowances, parting line, running system details. Prepare the mold and make the casting. Investigate the casting defects and suggest the remedial measures.
2. To make a component involving horizontal and vertical welding and study the welding defects and suggests their remedies.
3. To prepare a job on surface grinder/cylindrical grinder and measure the various parameters of the finished piece.
4. To cut external threads on a lathe.
5. Leveling of machine tools and testing their accuracy.
6. Disassembly and assembly of small assemblies such as tail stock, bench vice, screw jack etc.
7. Development and manufacture of complex sheet-metal components such as funnel etc.
8. Multi slot cutting on milling machine by indexing.
9. Drilling and boring of a bush.
10. To study and prepare a job on wire electric discharge machine.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

THERMODYNAMICS (THEORY)

General Course Information

Course Code: PCC-ME203-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe the conditions involving heat and work interactions.	L1
CO2	Students will be able to differentiate high and low grade energies.	L2
CO3	Students will be able to solve the problems involving change in thermodynamic properties of substances.	L3
CO4	Students will be able to examine and compare the performance of energy conversion devices.	L4

Course Contents

UNIT-I

Basic Concepts: Macroscopic and Microscopic Approaches, Thermodynamic Systems, Surrounding and Boundary, Thermodynamic Property– Intensive and Extensive, Thermodynamic Equilibrium, State, Path, Process and Cycle, Quasistatic, Reversible and Irreversible Processes, Working Substance, Concept of Thermodynamic Work and Heat, Equality of Temperature, Zeroth Law of Thermodynamic and its utility. Problems.

First Law of Thermodynamics: Energy and its Forms, Energy and 1st law of Thermodynamics, Internal Energy and Enthalpy, PMM-1, Steady flow energy equation, 1st Law Applied to Non- flow process, Steady Flow Process and Transient Flow Process, Throttling Process and Free Expansion Process. Problems.

UNIT-II

Second Law of Thermodynamics: Limitations of First Law, Thermal Reservoir, Heat Source and Heat Sink, Heat Engine, Refrigerator and Heat Pump, Kelvin- Planck and Clausius Statements and their Equivalence, PMM-2, Carnot Cycle, Carnot Heat Engine and Carnot Heat Pump, Carnot Theorem and its Corollaries, Thermodynamic Temperature Scale, Entropy, Clausius Inequality, Principle of Entropy Increase, Temperature Entropy Plot, Entropy Change in Different Processes, Introduction to Third Law of Thermodynamics. Problems.

Availability and Irreversibility: High and Low Grade Energy, Availability and Unavailable Energy, Loss of Available Energy Due to Heat Transfer Through a Finite Temperature Difference, Dead state of a system, Availability of a Non- Flow or Closed System, Availability of a Steady Flow System, Helmholtz and Gibb's Functions, Effectiveness and Irreversibility, Second law efficiencies of processes & cycles. Problems.

UNIT-III

Ideal and Real Gases: Concept of an Ideal Gas, Basic Gas Laws, Characteristic Gas Equation, Avogadro's law and Universal Gas Constant, P-V-T surface of an Ideal Gas, Vander Waal's Equation of state, Reduced Co-ordinates,

Compressibility factor and law of corresponding states, Mixture of Gases, Mass, Mole and Volume Fraction, Gibson Dalton's law, Gas Constant and Specific Heats, Entropy for a mixture of non-reactive gases. Problems.

Pure Substance: Pure Substance and its Properties, Phase and Phase Transformation, Vaporization, Evaporation and Boiling, Saturated and Superheat Steam, Solid – Liquid – Vapour Equilibrium, T-V, P-V and P-T Plots During Steam Formation, Properties of Dry, Wet and Superheated Steam, Property Changes During Steam Processes, Temperature – Entropy (T-S) and Enthalpy – Entropy (H-S) Diagrams, Throttling and Measurement of Dryness Fraction of Steam. Problems.

UNIT-IV

Thermodynamic Air Cycles: Introduction, Assumptions in Thermodynamic Cycles, Classifications of Thermodynamic Cycles, Reversible Cycle, Irreversible Cycle, Working of an Ideal Engine, Stirling Cycle, Ericsson Cycle, Bryton Cycle, Otto Cycle, Diesel Cycle, Dual Combustion Cycle. Problems.

Thermodynamic Relations: Maxwell Relations, Clapeyron Equation, Relations for changes in Enthalpy and Internal Energy & Entropy, Specific Heat Capacity Relations, Joule Thomson coefficient & inversion curve.

Text and Reference Books

1. Advanced engineering thermodynamics – Adrian Bejan, Wiley, 4th edition.
2. Engineering thermodynamics- P. Chattopadhay, OXFORD, Revised 1st edition.
3. Thermodynamics: An Engineering Approach- Yunus Cengel and Michael Boles, Tata McGraw Hill, 8th edition.
4. Engineering Thermodynamics - P K Nag, Tata McGraw Hill, 5th edition.
5. Fundamentals of Engineering Thermodynamics - Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, Wiley, 7th edition.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	2	1	1	1	1	1	2	3	3	1
CO2	3	3	3	2	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	3	--	3	1	1	2	2	2	2	3	3	2
CO4	3	3	3	3	--	3	1	1	2	2	2	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

4th Semester

NUMERICAL METHODS (THEORY)

General Course Information

Course Code: BSC-202-T Course Category: Basic Science Course Course Credits: 2.0 Contact Hours: 2 hours/week Mode: Lectures Examination Duration: 3 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to memorize and describe various interpolation formulae	L1
CO2	Students will be able to make comparison between direct and iterative methods	L2
CO3	Students will be able to solve problems relating to numerical differentiation and integration	L3
CO4	Students will be able to differentiate between single step and multi-step methods of ordinary differential equations	L4
CO5	Students will be able to construct polynomial from the tabular data	L5

Course Contents

UNIT-I

Finite differences operators and their relationship, difference table. Interpolation with equal intervals: Newton-Gregory forward & backward interpolation formulae. Central Differences interpolation: Gauss's forward and backward difference interpolation formulae. Interpolation with unequal intervals: Lagrange interpolation, Newton Divided difference.

UNIT-II

Non-Linear Equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson's method, Newton's iterative method for finding pth root of a number. Simultaneous Linear Algebraic Equations: Gauss Elimination method, Gauss-Jordan method, Jacobi's method, Gauss-Seidal method, Relaxation method.

UNIT-III

Numerical Differentiation: Derivatives from differences tables, Higher order derivatives. Numerical Integration: Newton -Cotes integration formula, Trapezoidal rule, Simpson's one- third rule and Simpson's three-eighth rule, Boole's rule and Weddle's rule.

UNIT-IV

Numerical Solution of Ordinary Differential Equations: Taylor series method, Euler method, modified Euler method, and Runge-Kutta methods. Multiple step methods of Ordinary Differential Equations: Predictor-corrector method, Milne's method, Adams-Moulton method.

Text and Reference Books

1. Applied Numerical Analysis: Curtis F. Gerald and Patrick G. Wheatley, Person, Education Ltd.
2. Numerical Method: E. Balagurusamy, TataMcGraw-Hill
3. Numerical methods for Scientific and Engg. Computations: M.K. Jain, S.R.K. Iyengar and R.K. Jain, Wiley Eastern Ltd.
4. Introductory methods of Numerical Analysis: S.S. Sastry, P.H.D.
5. Numerical Methods in Engg. & Science: B.S. Grewal.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	--	2	1	--	--	--	--	--	--	--	--	1	--
CO2	3	2	--	2	2	--	--	--	--	--	--	--	--	1	--
CO3	3	3	--	3	2	--	--	--	--	--	--	--	--	2	--
CO4	3	3	--	3	2	--	--	--	--	--	--	--	--	2	--
CO5	1	2	--	2	1	--	--	--	--	--	--	--	--	1	--

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

NUMERICAL METHODS (LAB)

General Course Information

Course Code: BSC-202-P Course Category: Basic Science Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to memorize and describe various data types and file handling functions	L1
CO2	Students will be able to translate given algorithm to a working and correct program in C language	L2
CO3	Students will be able to write, compile and debug programs in C language	L3
CO4	Students will be able to compare and contrast algorithms to solve mathematical problems	L4
CO5	Students will be able to evaluate the numerical solutions of mathematical problems using C programming language	L5
CO6	Students will be able to assemble object oriented features of C programming language in developing the programs to solve real world problems	L6

Lab Contents

Write down and execute the following programs using C :

1. To interpolate the data using Newton's forward/ backward interpolation formula
2. To interpolate the data using Gauss's forward/ backward interpolation formula
3. To interpolate the data using Lagrange's interpolation formula
4. To compute derivatives of a tabulated function at a specified value using the Newton's interpolation approach.
5. To find the roots of non-linear equation using Bisection method.
6. To find the roots of non-linear equation using Regula-Falsi method.
7. To find the roots of non-linear equation using Newton-Raphson method.
8. To solve the system of linear equations using Gauss -elimination method.
9. To solve the system of linear equations using Gauss -Seidal iteration method.
10. To solve the system of linear equation using Gauss – Jordan method.
11. To integrate numerically using Trapezoidal rule.
12. To integrate numerically using Simpson's rules.
13. To find numerical solution of ordinary differential equations by Euler's method/ Modified Euler's method.
14. To find numerical solution of ordinary differential equations by Runge -Kutta method.
15. To find numerical solution of ordinary differential equations by Milne's method.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Text and Reference Books

1. Applied Numerical Analysis: Curtis F. Gerald and Patrick G. Wheatley - Pearson Education Ltd.
2. Numerical Methods : E. Balagurusamy, Tata McGraw-Hill.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	--	--	--	--	--	--	--	--	2	2
CO2	3	2	3	2	2	--	--	--	--	--	--	--	--	2	2
CO3	3	3	3	3	2	--	--	--	--	--	--	--	--	2	2
CO4	3	3	3	3	3	--	--	--	--	--	--	--	--	2	2
CO5	3	3	3	3	2	--	--	--	--	--	--	--	--	2	2
CO6	3	2	3	2	3	--	--	--	--	--	--	--	--	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MATERIAL SCIENCE (THEORY)

General Course Information

Course Code: PCC-ME204-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define crystals, its basic concepts, imperfection in crystals, equilibrium diagrams and their objectives.	L1
CO2	Students will be able to understand phase & phase diagram, heat treatment, failure of materials & their protection, applications of materials	L2
CO3	Students will be able to examine the mechanical behavior of materials in different operating conditions	L3
CO4	Students will be able to select the materials accordance to their structure and properties.	L4

Course Contents

UNIT-I

Crystallography: Review of crystal structure, space lattice, crystal planes and crystal directions, co-ordination number, number of atoms per unit cell, atomic packing factor, Numericals related to crystallography.

Imperfection in metal crystals: Crystal imperfections and their classifications, point defects, line defects, edge & screw dislocations, surface defects, volume defects & effects of imperfections on metal properties.

UNIT-II

Solid solutions and phase diagram: Introduction to single and multiphase solid solutions and types of solid solutions, importance and objectives of phase diagram, systems, phase and structural constituents, cooling curves, unary & binary phase diagrams, Gibbs's phase rule, Lever rule, eutectic and eutectoid systems, peritectic and peritectoid systems, iron carbon equilibrium diagram and TTT diagram.

Heat Treatment: Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering, carburizing, nitriding, cyaniding, flame and induction hardening, Allotropic transformation of iron and steel, Properties of austenite, ferrite, pearlite, martensite.

UNIT-III

Deformation of Metal: Elastic and plastic deformation, mechanism of plastic deformation, twinning, conventional and true stress strain curves for polycrystalline materials, yield point phenomena, strain ageing, work hardening, Bauschinger effect, season cracking, Recovery, re-crystallization and grain growth.

Failures of metals: Failure analysis, fracture, process of fracture, types of fracture, fatigue, characteristics of fatigue, fatigue limit, mechanism of fatigue, factors affecting fatigue.

UNIT-IV

Creep & Corrosion: Definition and concept, creep curve, mechanism of creep, impact of time and temperature on creep, creep fracture, creep testing and prevention against creep. Corrosion: Mechanism and effect of corrosion, prevention of corrosion.

Plastic, Composite and Ceramics: Polymers, formation of polymers, polymer structure and crystallinity, polymers to plastics types, reinforced particles-strengthened and dispersion strengthened composites. Ceramic materials: Types of ceramics, properties of ceramic, ceramic forming techniques, mechanical behavior of ceramic.

Text and Reference Books

1. Elements of Material Science and Engineering: VanVlack, Wesley Pub. Comp.
2. Material Science - Narula, Narula and Gupta. New Age Publishers
3. Material Science & Engineering –V. Raghvan, Prentice Hall of India Pvt. Ltd, New Delhi
4. A Text Book of Material Science & Metallurgy – O.P. Khanna, Dhanpat Rai & Sons
5. Material Science and Engineering-An Introduction - Callister; W.D., John Wiley & Sons., Delhi.
6. Engineering Materials: Kenneth G. Budinski, Prentice Hall of India, New Delhi

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	--	2	1	1	1	2	--	2	3	2	2
CO2	3	2	2	1	--	2	1	1	2	2	--	2	3	2	2
CO3	3	1	2	1	--	3	1	1	2	2	--	2	3	2	2
CO4	3	1	2	1	--	3	1	1	2	2	--	3	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MATERIAL SCIENCE (LAB)

General Course Information

Course Code: PCC-ME204-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the basic concepts of crystalline materials, phase & phase diagram, heat treatment process & types	L1
CO2	Students will be able to select the materials accordance to their structure and properties.	L2
CO3	Students will be able to analyze the structure of materials at different levels	L3
CO4	Students will be able to examine crystals imperfections	L4

Lab Contents

1. To study crystal structures of a given specimen.
2. To study crystal imperfections in a given specimen.
3. To study microstructures of metals/ alloys.
4. To prepare solidification curve for a given specimen.
5. To study heat treatment processes (hardening and tempering) of steel specimen.
6. To study microstructure of heat-treated steel.
7. To study thermo-setting of plastics.
8. To study the creep behavior of a given specimen.
9. To study the mechanism of chemical corrosion and its protection.
10. To study the properties of various types of plastics.
11. To study Bravais lattices with the help of models.
12. To study crystal structures and crystals imperfections using ball models.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	--	--	1	1	--	1	--	3	3	3	2
CO2	3	1	2	1	--	--	1	1	--	1	1	3	3	3	2
CO3	3	3	3	2	3	--	1	1	2	2	1	3	3	3	2
CO4	3	3	3	2	3	--	1	1	2	2	2	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

FLUID MECHANICS (THEORY)

General Course Information

Course Code: PCC-ME205-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorials Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the fluid, its properties and various laws governing fluid flow.	L1
CO2	Students will be able to identify and explain fluid flow under static, kinematics and dynamic conditions.	L2
CO3	Students will be able to apply engineering knowledge to solve the fluid flow problems under given conditions.	L3
CO4	Students will be able to examine flow through pipes and boundary layer phenomenon on a flat surface.	L4
CO5	Students will be able to evaluate various parameters related to laminar and turbulent flows.	L5

Course Contents

UNIT-I

Fluid Properties and Fluid Statics: Introduction, fluid continuum, fluid properties, types of fluids, Pascal's law, hydrostatic law, Manometers: simple and differential, Hydrostatic forces on plane and curved surfaces, Buoyancy and Flotation: Centre of buoyancy, Archimedes' principle, Metacentre and Metacentric height, Stability of floating and submerged bodies, Numerical Problems.

Fluid Kinematics: Types of fluid flows, description of fluid flow: stream, streak, path and time lines, Eulerian and Lagrangian methods, flow rate and continuity equation in 3-D and in cylindrical and polar coordinates, rotation, vorticity and circulation, stream and potential functions, flow net, Numerical Problems.

UNIT-II

Fluid Dynamics: Energy and forces acting on a flowing fluid, Equations of motion, Euler's equation, Bernoulli's equation, Venturimeter, orifice meter, Pitot tube, Impulse momentum relationship and its applications, Numerical Problems.

Orifices, Mouthpieces, Notches and Weirs: Classification of orifices and mouthpieces, Hydraulic coefficients, Discharge through a large rectangular orifice, Time of emptying a tank through an orifice, Classifications of notches and weirs, Empirical formulae for discharge over rectangular weirs, Discharge over rectangular & triangular notch or weir, Numerical Problems.

UNIT-III

Laminar Flow (Viscous Flow): Introduction, Reynolds experiment, Laminar flow in circular pipes (Hagen-Poiseuille theory), Laminar flow between two parallel plates when both plates are at rest, Laminar flow between two parallel plates when one plate moves and other at rest (Couette flow), Numerical Problems.

Turbulent Flow: Loss of head in pipes (Darcy-Weisbach equation), Characteristics of turbulent flow (turbulence), Shear stresses in turbulent flow: Boussinesq's theory, Reynolds theory, Prandtl's mixing length theory, Von-Karman similarity concept, Universal velocity distribution equation, hydrodynamically smooth and rough boundaries, velocity distribution for smooth and rough pipes, friction coefficients for smooth and rough pipes, Moody diagram, Numerical Problems.

UNIT-IV

Flow Through Pipes: Major and minor head losses in pipes, hydraulic gradient and total energy lines, Pipes in series and parallel, equivalent pipe, branched pipes, power transmission through pipes, numerical Problems.

Boundary Layer Flow: Description of boundary layer, displacement, momentum and energy thickness, Drag force on a flat plate (Von Karman momentum integral equation), Blasius solution for laminar boundary layer flows, Velocity profiles for laminar boundary layer, boundary layer separation and control, Numerical Problems.

Text and Reference Books

1. Fluid Mechanics and Hydraulics Machines, Mahesh Kumar, Pearson Education, 2019.
2. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
3. Mechanics of Fluids – I H Shames, Mc Graw Hill
4. A text book of Fluid Mechanics and Hydraulic Machines", R.K Rajput., S. Chand & Company Ltd., New Delhi
5. Fluid Mechanics and Hydraulics Machines, R.K. Bansal, Laxmi publications (P) Ltd., New Delhi
6. Hydraulics and Fluid Mechanics, Modi P.N., & Seth S.M Standard Book House, New Delhi
7. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, TMH
8. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
9. Fluid Mechanics and Machinery – S.K. Agarwal, TMH, New Delhi
10. Fluid Mechanics, Yunus A Cengel & John M. Cimbala, Tata McGraw Hill Edition, New Delhi, 2006
11. Fluid Mechanics White, F.M, Tata McGraw-Hill, 5th Edition, New Delhi, 2003.
12. Fluid Mechanics & Fluid Machines: Basic Concepts & Principles, Shiv Kumar, Ane Books Pvt. Ltd., New Delhi, 2010.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	--	1	1	--	2	1	1	--	1	--	3	3	2	3
CO2	3	3	2	2	1	3	2	--	1	1	1	3	2	1	3
CO3	3	2	3	3	2	2	2	2	2	2	1	3	2	2	2
CO4	3	2	2	2	1	2	2	--	--	2	2	3	3	2	3
CO5	3	2	2	2	3	2	2	--	1	2	2	3	3	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

FLUID MECHANICS (LAB)

General Course Information

Course Code: PCC-ME205-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe the fundamentals involved in measuring various performance parameters.	L1
CO2	Students will be able to understand the working of various flow meters.	L2
CO3	Students will be able to operate flow discharge measuring device used in pipes channels.	L3
CO4	Students will be able to examine types of flow and major and minor losses during fluid flow.	L4
CO5	Students will be able to Evaluate the error between theoretical and experimental results.	L5

Lab Contents

1. To verify the Bernoullis Theorem.
2. To determine the coefficient of discharge of an orifice meter.
3. To determine the coefficient of discharge of venturimeter.
4. To determine the coefficient of discharge of Notch (V and Rectangular types).
5. To determine the major loss due to friction in pipe flow.
6. To determine the coefficient of discharge, contraction & velocity of an orifice.
7. To find critical Reynolds number for a pipe flow.
8. To determine the meta-centric height of a floating body.
9. To determine the minor losses due to pipe fittings in pipes
10. To determine the density and viscosity of any three fluids.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	--	1	--	1	1	2	--	3	3	2	2
CO2	3	1	1	1	--	1	--	1	2	2	--	3	2	2	2
CO3	3	2	2	3	2	1	2	2	3	3	--	3	2	2	2
CO4	3	1	3	3	3	2	3	2	2	3	2	3	2	3	2
CO5	3	1	3	3	3	2	2	2	2	3	3	3	2	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

STEAM AND POWER GENERATION (THEORY)

General Course Information

Course Code: PCC-ME206-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define combustion process of fuels and change in thermodynamic properties of steam in boilers, turbines, engines and condensers.	L1
CO2	Students will be able to discuss the construction and working of bomb calorimeter, steam generators, steam turbines, steam engines and steam condensers.	L2
CO3	Students will be able to examine the process of energy conversion in fuel combustion and steam power generating devices.	L3
CO4	Students will be able to formulate the performance parameters for the equipments used in fuel combustion and power generation through steam.	L4

Course Contents

UNIT- I

Fuels and Combustion: Characteristics of fuels, Laws of combustion and reactions, Gravimetric and volumetric analysis, Air-fuel ratio, Exhaust gas analysis, Orsat apparatus. Calorific values of fuel, Bomb calorimeter, Numericals.

Steam: Formation of steam at constant pressure, Variation in steam properties during phase change, Steam tables and their uses, Enthalpy – entropy (Mollier) diagram, Carnot and Rankine vapour cycles, Rankine cycle with reheat and regeneration, Numericals.

UNIT - II

Steam Generators: Classification of steam boilers, Essentials of a good boiler, Construction and operational details of Cochran, Babcock Wilcox, Locomotive, Benson, Lamont, and Loeffler Boilers, Boiler mountings and accessories.

Boiler Draught (Draft) and Performance: Natural (Chimney) draught, Maximum discharge through a chimney, Artificial draught, Evaporative capacity and efficiency of boilers, Energy balance in a boiler, Numericals.

UNIT - III

Steam Nozzles: Steam flow through a nozzle, Critical pressure ratio (maximum discharge condition) and its physical significance, Flow through actual nozzles, Supersaturated expansion of steam, Numericals.

Steam Turbines: Working principle of impulse and reaction steam turbines, Vector diagrams of velocities, Optimum operating conditions of turbines, Compounding of impulse turbines, Performance analysis of steam turbines, Numericals.

UNIT - IV

Steam Engines: Construction and working of steam engines, Indicator diagrams, Performance of steam engines, Governing of steam engines, Numericals.

Steam Condensers: Elements of a condensing plant, Types of condensers, Comparison of jet and surface condensers, Condenser and vacuum efficiency, Cooling towers, Numericals.

Text and Reference Books

1. P. L. Ballaney, "Thermal Engineering", Khanna Publishers, 2005
2. Mahesh M. Rathore, "Thermal Engineering", Tata McGraw-Hill Education, 2010
3. R. K. Rajput, "Thermal Engineering", Laxmi Publication, 2018.
4. D. S. Kumar, "Steam and Power Generation", S.K. Kataria and Sons, 2012

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO2	3	3	2	1	--	2	3	1	1	2	1	3	3	3	3
CO3	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO4	3	3	3	1	--	2	2	1	1	2	1	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MECHANICS OF SOLIDS-II (THEORY)

General Course Information

Course Code: PCC-ME207-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorials Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to determine stresses in pressure vessels, beam columns, rotating rims & discs and springs.	L1
CO2	Students will be able to calculate slope and deflection in various beams subjected to different types of transverse loads using Energy, Double Integration, Macaulay's and Area Moment methods.	L2
CO3	Students will be able to carry out stress-strain analysis in solids subjected to bi-axial, tri-axial and combined torsion, bending & axial loads.	L3
CO4	Students will be able to design mechanical components such as pressure vessels, springs, flywheels, shaft, etc. in accordance with realistic constraints of safety and economical constraints.	L4

Course Contents

UNIT-I

Thin Pressure Vessels: Hoop and Longitudinal stresses & strains in cylindrical and spherical vessels under internal pressure, wire would thin cylinders.

Thick Cylinders & Spheres: Derivation of Lame's equations, radial & hoop stresses and strains in thick and compound cylinders and spherical shells subjected to internal fluid pressure only, wire wound cylinders, hub shrunk on solid shaft.

UNIT-II

Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength, stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders

Beam columns: Beam columns subjected to single concentrated load, number of concentrated loads, continuous lateral Load, end couple, couples at both ends triangular loads.

UNIT-III

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's & Maxwell's theorems.

Springs: Stresses in open coiled helical spring subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs.

UNIT-IV

Slope & deflection: Relationship between bending moment, slope & deflection, calculations for slope and deflection using Integration, Macaulay's and area moment methods of (i) cantilevers and (ii) simply supported beams with or without overhang (iii) fixed beams under (i) concentrated loads, (ii) uniformly distributed load and (iii) a combination of concentrated loads & uniformly distributed load (iv) varying load (v) application of moments, propped beams, sinking of prop, continuous beams.

Theories of Elastic Failure: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading.

Text and Reference Books

1. Mechanics of Solid by Muubeen Abdul, Pearson Publications, India.
2. Engineering Mechanics of Solids by Popov E.P, Prentice Hall of India Mechanics of Materials by Ferdinand P. Beer and E. Russel Johnston, Jr. Second Edition, McGraw Hill.
3. Solid Mechanics by Kazmi, Tata Mc Graw Hill.
4. Strength of Materials by G.H.Ryder, Macmillan, India.
5. Strength of Materials by D.S. Bedi, S. Chand & Co. Ltd.
6. Advanced Mechanics of Solids and Structures by N. Krishan Raju and D.R.Gururaje, Narosa Publishing House.
7. Strength of Materials by Andrew Pytel and Fredinand L. Singer, Int. Student Ed. Addison, Wesley Longman.
8. Strength of Materials by Sadhu Singh, Khanna Publishers, India.
9. Strength of Materials by Timoshenko S, East-West Press Pvt. Ltd., New Delhi.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	--	--	--	1	1	2	3	3	3	1
CO2	3	2	2	2	2	--	--	--	1	1	2	3	3	3	1
CO3	3	2	3	2	2	--	--	--	1	1	2	3	3	3	1
CO4	3	2	3	2	2	--	--	--	1	1	2	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

SKILLS AND INNOVATION (LAB)

General Course Information

Course Code: PROJ-ME201-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to explore novel ideas/modified techniques on topics related to Mechanical Engineering.	L1
CO2	Students will be able to work in groups and collectively mange to present their ideas into a concept.	L2
CO3	Students will be able to identify and interpret practical problems/issues in existing mechanical systems.	L3
CO4	Students will be able to employ modern design and analysis tools for carrying out their project work.	L4

Course Contents

A group of 5-7 students are required to carry out a project related to current research & development in the field of Mechanical Engineering. Each group of students will try to propose a novel idea/modified technique/new interpretation after identifying an existing research work. They will work towards finding solutions to the identified problem such as cost reduction, enable new processes and/or materials, create a higher impact than the existing practices etc. using their innovative ideas and concept generation abilities.

The topic of the project will be decided by the students in consultation with the course coordinator. The project report will be submitted by a group at the end of semester. The students may use the equipments/machines/instruments available in the labs/workshops with the due permission of Chairperson on recommendation of the course coordinator.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	--	2	--	3	--	2	2	2	2	3
CO2	3	2	2	2	--	--	2	--	3	2	2	2	2	2	3
CO3	3	3	2	2	--	--	2	--	--	2	2	2	2	2	3
CO4	3	--	2	2	3	--	2	--	--	--	2	2	2	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

5th Semester

KINEMATICS OF MACHINES (THEORY)

General Course Information

Course Code: PCC-ME301-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the various terminologies of kinematics of machines like element, kinematic pair, kinematic chain, mechanism, machine, motion of elements and fundamental laws of kinematics.	L1
CO2	Students will be able to describe the concept of mechanisms, machines, their components and relative motion between them.	L2
CO3	Students will be able to solve different kind of problems related to machines and mechanisms while applying the principles of kinematics.	L3
CO4	Students will be able to analyse different mechanisms for displacement, velocity and acceleration graphically.	L4
CO5	Students will be able to select and design appropriate mechanism required for a specific type of relative motion and for a particular application.	L5

Course Contents

UNIT-I

Introduction: Mechanism and Machines, Kinematic Links, Kinematic Pairs, Kinematic Chains, Degree of Freedom, Kinematic Inversion, Inversions of Four Bar Kinematic Chain, Inversions of Single Slider Kinematic Chain, Inversions of Double Slider Kinematic Chain, Problems

Mechanism with Lower Pairs: Pantograph, Straight Line Mechanisms, Exact Straight Line Motion Mechanisms, Approximate Straight Line Motion Mechanisms, Steering Gear Mechanisms, Davis Steering Gear, Ackerman Steering Gear, Problems

UNIT-II

Velocity in Mechanisms: Relative Velocity Method: Motion of a Link, Velocity of a Point on a Link by Relative Velocity Method, Velocities in a Slider Crank Mechanism, Instantaneous Centre Method: Space and Body Centrodes, Velocity of a Point on a Link by Instantaneous Centre Method, Aronhold Kennedy Theorem, Methods of Locating Instantaneous Centres in a Mechanism, Problems

Acceleration in Mechanisms: Acceleration diagram for a link, Acceleration of a point on a link. Acceleration in the Slider Crank Mechanism, Coriolis Component of Acceleration, Problems

UNIT-III

Cams: Classification of Cams and Followers, Disc Cam Nomenclature, Construction of Displacement, Velocity and Acceleration Diagrams for Different Types of Follower Motions, Determination of Basic Dimension, Synthesis of Cam Profile by Graphical Approaches, Problems

Kinematic Synthesis: Kinematic Synthesis: Dimensional synthesis, function generation, path generation and motion generation, Synthesis of Four Bar linkage for specified Instantaneous conditions, Problems

UNIT-IV

Gears: Fundamental Law of Gearing, Forms of Gear Teeth, Path of Contact, Arc of Contact, Interference and Undercutting, Non Standard Gear Teeth, Helical, Spiral, Bevel and Worm Gears, Problems

Gear Trains: Synthesis of Simple, Compound and Reverted Gear Trains, Analysis of Epicyclic Gear Trains, Problems

Text and References Books

1. KJ, Waldron and GL, Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley Publishers, Edition, 2016.
2. A, Ghosh and AK, Malik, Theory of Mechanisms and Machines, East West Press Private Limited Publishers, Edition, 2017.
3. JJ, Uicker (Jr), GR, Pennock and JE, Shigley, Theory of Machines and Mechanisms, Oxford Publishers, 2016.
4. SS, Rattan, Theory of Machines, Tata McGraw Hill Publishers, Edition, 2017.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

KINEMATICS OF MACHINES (LAB)

General Course Information

Course Code: PCC-ME301-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to name various terms related to kinematics of machines like link, kinematic pair, kinematic chain, mechanism and machine.	L1
CO2	Students will be able to describe link, kinematic pair, kinematic chain, mechanism and machine through models.	L2
CO3	Students will be able to solve different kind of problems related to links, mechanisms and machines experimentally.	L3
CO4	Students will be able to analyse different links, kinematic pairs, kinematic chains, mechanisms though models and experimentally.	L4
CO5	Students will be able to select and design appropriate element, pair, mechanism and machine required for a particular application.	L5

Lab Contents

1. To Study Various Types of Kinematic Links, Pairs, Chains and Mechanisms.
2. To Study Inversions of Four Bar, Single Slider and Double Slider Crank Chains.
3. To Find Coefficient of Friction Between Belt and Pulley, and Rope and Pulley.
4. To Study Various Types of Cam and Follower Arrangements.
5. To Plot Follower Displacement Vs Cam Rotation for Various Cam Follower Systems.
6. To Generate Spur Gear Involute Tooth Profile using Simulated Gear Shaping Process.
7. To Study Various Types of Gears: Spur, Helical, Double Helical, Worm, Spiral and Bevel Gears.
8. To Study Various Types of Gear Trains: Simple, Compound, Reverted and Epicyclic Gear Trains.
9. To Determine the Speed Ratio of a Gear Train.
10. To Compute the Efficiency of an Epicyclic Gear Train.
11. Create various types of linkage mechanism in CAD and simulate for motion outputs and study the relevant effects.
12. Creation of various joints like revolute, planes, spherical, cam follower and study the degree of freedom and motion patterns available.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

HYDRAULIC MACHINES (THEORY)

General Course Information

Course Code: PCC-ME302-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorials Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the fundamentals of hydraulic turbines, pumps, and systems.	L1
CO2	Students will be able to understand the constructional details and working principle of hydraulic machines.	L2
CO3	Students will be able to solve the problems related to designs of hydraulic machines.	L3
CO4	Students will be able to evaluate the performance of turbines, pumps and other hydraulic systems.	L4

Course Contents

UNIT-I

Impact of free jets & Basics of Fluid Machines: Introduction, Impulse momentum principle, Force exerted by a jet on a stationary and moving vertical flat plate, Force exerted by a jet on stationary and moving inclined flat plate, Force exerted by a jet on stationary and moving curved vane, Force exerted by a jet on a series of flat plates, Force exerted by a jet on a series of radial curved vanes, Force exerted by a jet on a hinged plate, Jet propulsion of ships, general classification of fluid machines, Hydraulic machines and its main parts, Numerical Problems.

Pelton Turbine (Impulse Turbine): Introduction, Classification of hydraulic turbines, Impulse turbine operation principle, General layout of a hydro-electric power plant, Heads and efficiencies of a hydraulic turbine, Water wheel, Pelton turbine (Pelton wheel), Governing of Pelton turbines, Velocity triangles, work done, and efficiency of the Pelton turbine, Design aspects of the Pelton turbine, Numerical Problems.

.

UNIT-II

Francis Turbine (Radial Flow Reaction Turbines): Introduction, Radial flow reaction turbines: inward and outward radial flow reaction turbines, Construction, working operation and governing of Francis turbine, Velocity triangles, work done, and efficiency of radial flow reaction turbines and Francis turbine, Degree of reaction, Working proportions of a Francis turbine and radial flow reaction turbines, Design and shape of Francis turbine runner, Numerical Problems.

Propeller & Kaplan Turbines and Performances of Hydraulic Turbines: Introduction, Construction and working of Propeller and Kaplan turbines, Governing of Kaplan turbines, Working proportions of Kaplan and propeller turbines, Draft tube: Theory & its Efficiency, Cavitation in turbines, Introduction to New types of turbines: Deriaz, Tubular and Bulb turbines, Unit quantities: speed, discharge and power, Specific speed, Model relationship and testing of turbines, Characteristic curves, Selection of turbines, Numerical problems.

UNIT-III

Centrifugal Pumps: Introduction, Classification of pumps, Construction and working of centrifugal pumps, Priming devices, Velocity triangles and work done by centrifugal pump, Head of a centrifugal pump, Pressure rise in the impeller, Losses, power and efficiencies of centrifugal pumps, Effect of outlet vane angle on manometric efficiency, Slip factor, Minimum starting speed, Design considerations, Multistage pumps, Specific speed of centrifugal pumps, Model testing of centrifugal pumps, Performance characteristics of centrifugal pumps, Maximum suction lift, Net positive suction head (NPSH), Cavitation in centrifugal pumps, Numerical problems.

Reciprocating Pumps: Introduction, Main parts and working of a reciprocating pump, Discharge, work done, and power required for driving single and double acting reciprocating pumps, Effect of variation of velocity in the suction and delivery pipes, Indicator diagrams: Maximum speed of a reciprocating pump and Effect of acceleration and friction in suction and delivery pipes on indicator diagram, Air vessels: Work done by a reciprocating pump and its Maximum speed with air vessel, Characteristic curves of a reciprocating pump, Rotary positive displacement pumps and Numerical problems.

UNIT-IV

Dimensional Analysis and Model Similitude: Introduction, Dimensional homogeneity, Methods of dimensional analysis: Rayleigh and Buckingham pi methods, Similitude-types of similarities, Dimensionless numbers and their significance, Similarity laws or model laws: Reynolds model law, Froude model law, Euler model law, Weber model law, Mach model law, Types of models, Scale effects in models and numerical problems

Hydraulic systems: Introduction, Hydraulic press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic ram, Hydraulic lift, Hydraulic crane, Hydraulic coupling, Hydraulic torque converter and Numerical problems.

Text and Reference Books

1. Fluid Mechanics and Hydraulics Machines, Mahesh Kumar, Pearson Education, 2019.
2. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi, 2010
3. Hydraulic Machines – Jagdish Lal, Metropolitan, 1998
4. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers, 1998
5. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill, 2009
6. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons, 2010
7. Fluid Mechanics and Hydraulic Machines-R. K. Rajput, S. Chand & Company, 2014
8. Fluid Mechanics and Hydraulic Machines-R. K. Bansal, Laxmi Publications, 2010
9. Fluid Mechanics-Cengel and Cimbala, Mc Graw Hill Education, 2014

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	--	2	3	2	2	3	--	3	3	3	2
CO2	3	1	1	--	--	2	3	2	2	3	--	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2
CO4	3	2	3	3	3	3	3	3	3	3	3	3	3	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

HYDRAULIC MACHINES (LAB)

General Course Information

Course Code: PCC-ME302-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn the basics elements of hydraulic machines and their layout.	L1
CO2	Students will be able to classify hydraulic machines.	L2
CO3	Students will be able to operate hydraulic machines and evaluate their performance.	L3
CO4	Students will be able to compare the performance of hydraulic machines and able to create characteristic curves at given conditions.	L4

Lab Contents

1. To determine the water power, mechanical power and efficiency of a Pelton turbine.
2. To draw the following performance characteristics of Pelton turbine-constant head, constant-speed and constant efficiency curves.
3. To determine the hydraulic efficiency of a Francis turbine.
4. To draw the constant head, constant speed and constant efficiency performance characteristics of a Francis turbine.
5. To study the construction details of a Kaplan turbine and draw its fluid flow circuit.
6. To draw the constant head, speed and efficiency curves for a Kaplan turbine.
7. To study the constructional details of a Centrifugal Pump and evaluate its performance at different operating conditions.
8. To study the constructional details of a Reciprocating Pump and draw its characteristics curves.
9. To study the construction details of a Gear oil pump and its performance curves.
10. To study the constructional details of a Hydraulic Ram and determine its efficiency.
11. To study the model of Hydro power plant and draw its layout.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	--	--	--	1	--	--	2	--	3	3	2	--
CO2	3	--	--	--	--	--	--	--	--	2	--	3	2	--	--
CO3	3	2	2	3	3	2	1	2	3	3	1	3	2	3	2
CO4	3	2	2	3	3	2	1	2	3	3	2	3	2	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

INTERNAL COMBUSTION ENGINES AND GAS TURBINES (THEORY)

General Course Information

Course Code: PCC-ME303-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe the basics of SI & CI, air standard cycles, rotary compressors, and gas turbines.	L1
CO2	Students will be able to explain the combustion phenomenon, lubrication and cooling of IC engines.	L2
CO3	Students will be able to demonstrate knowledge of the operating characteristics of common internal combustion engines.	L3
CO4	Students will be able to examine the operating conditions of IC engine, rotary compressor, and gas turbines.	L4
CO5	Students will be able to evaluate the performance parameters of IC engine, rotary compressor, and gas turbines.	L5

Course Contents

UNIT-I

Air Standard Cycles: Internal and external combustion engines; classification of I.C. Engines, Cycles of operation in four stroke and two stroke I.C. Engines, Wankel Engines, Assumptions made in air standard cycle; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; sterling and Ericsson cycles; air standard efficiency, specific work output, specific weight; work ratio; mean effective pressure; deviation of actual engine cycle from ideal cycle. Problems.

Carburetion, fuel Injection and Ignition systems: Mixture requirements for various operating conditions in S.I. Engines; elementary carburetor, Requirements of a diesel injection system; types of inject systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; spark plugs. Problems.

UNIT-II

Combustion in I.C. Engines: S.I. engines; Ignition limits; stages of combustion in S.I. Engines; Ignition lag; velocity of flame propagation; detonation; effects of engine variables on detonation; theories of detonation; octane rating of fuels; pre-ignition; S.I. engine combustion chambers, Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.

Lubrication and Cooling Systems: Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, engine performance and lubrication, Necessity of engine cooling; disadvantages of overcooling; cooling systems; air-cooling, water cooling; radiators.

UNIT-III

Engine Testing and Performance: Performance parameters: BHP, IHP, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, volumetric efficiency; specific fuel consumption (BSFC, ISFC), thermal efficiency; heat balance; Basic engine measurements; fuel and air consumption, brake power, indicated power and friction power, heat lost to coolant and exhaust gases; performance curves. Problems.

Air pollution from I.C. Engine and Its remedies: Pollutants from S.I. and C.I. Engines, Methods of emission control; alternative fuels for I.C. Engines; the current scenario on the pollution front.

UNIT-IV

Rotary Compressors: Root and vane blowers; Static and total head values; Centrifugal compressors- Velocity diagrams, slip factor, ratio of compression, pressure coefficient, pre-whirl; Axial flow compressor- Degree of reaction, polytropic efficincy, surging, choking and stalling, performance characteristics, Problems.

Gas Turbines: Brayton cycle; Components of a gas turbine plant; open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; multi stage compression with inter-cooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines. Problems.

Text and References Books

1. Internal Combustion Engines –V. Ganesan, Tata McGraw-Hill.
2. Engineering fundamental of the Internal Combustion Engine – W.W. Pulkrabek, Pearson Education, 2007.
3. Internal Combustion Engines & Air pollution- Obert E.F, Hopper & Row Pub., New York
4. Internal Combustion Engines Fundamentals- J. B. Heywood, McGraw Hill, New York
5. Internal Combustion Engines- V.M. Domkundwar, Dhanpat Rai &Co., 2008
6. Internal Combustion Engines- R.K. Rajput, Laxmi Publications, 2009
7. Internal Combustion Engines- Matur and Sharma, Dhanpat Rai &Co., 2007

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	1	1	1	1	1	1	3	3	3	1
CO2	3	3	3	2	--	1	1	1	1	1	1	3	3	3	1
CO3	3	3	3	2	--	1	1	1	1	1	1	3	3	3	1
CO4	3	3	3	2	--	1	1	2	3	2	2	3	3	3	3
CO5	3	3	3	2	--	1	1	2	3	2	2	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

INTERNAL COMBUSTION ENGINES AND GAS TURBINES (LAB)

General Course Information

Course Code: PCC-ME303-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the construction details of internal combustion engines.	L1
CO2	Students will be able to describe the working of commonly used petrol and diesel engines.	L2
CO3	Students will be able to apply performance and exhaust gas analysis tests on petrol and diesel engines.	L3
CO4	Students will be able to test the performance parameters of internal combustion engines.	L4
CO5	Students will be able to evaluate the efficiency and fuel consumption different internal combustion engines.	L5

Lab Contents

1. To study the constructional details & working principles of two-stroke/ four stroke petrol engine.
2. To study the constructional detail & working of two-stroke/ four stroke diesel engine.
3. Analysis of exhaust gases from single cylinder/multi cylinder diesel/petrol engine by Orsat Apparatus.
4. To prepare heat balance sheet on multi-cylinder diesel engine/petrol engine.
5. To find the indicated horse power (IHP) on multi-cylinder petrol engine/diesel engine by Morse Test.
6. To prepare variable speed performance test of a multi-cylinder/single cylinder petrol engine/diesel engine and prepare the curves (i) bhp, ihp, fhp, vs speed (ii) volumetric efficiency & indicated specific fuel consumption vs speed.
7. To find fhp of a multi-cylinder diesel engine/petrol engine by Willian's line method & by motoring method.
8. To perform constant speed performance test on a single cylinder/multi-cylinder diesel engine & draw curves of (i) bhp vs fuel rate, air rate and A/F and (ii) bhp vs mep, mechanical efficiency & sfc.
9. To measure CO & Hydrocarbons in the exhaust of 2- stroke / 4-stroke petrol engine.
10. To find intensity of smoke from a single cylinder / multi-cylinder diesel engine.
11. To draw the scavenging characteristic curves of single cylinder petrol engine.
12. To study the effects of secondary air flow on bhp, sfc, Mech. Efficiency & emission of a two-stroke petrol engine.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO2	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO3	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO4	3	3	3	2	-	2	2	2	2	3	2	3	3	3	3
CO5	3	3	3	2	-	2	2	2	2	3	2	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

DESIGN OF MACHINE ELEMENTS (THEORY)

General Course Information

Course Code: PCC-ME304-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 2; T: 2) Mode: Lectures and Tutorial Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the principles involved in evaluating the shape and dimensions of a component.	L1
CO2	Students will be able to formulate the design and manufacturing problem for simple and complex mechanical components.	L2
CO3	Students will be able to use catalogues and standard machine components.	L3
CO4	Students will be able to apply the general mechanical engineering sciences in analyses specific to the design of mechanical components and systems	L4

Course Contents

UNIT-I

Design for Variable loading: Variable Loading: Different types of fluctuating/ variable stresses, Fatigue strength considering stress concentration factor, surface factor, size factor, reliability factor etc., Fatigue design for finite and infinite life against combined variable stresses using Goodman and Soderberg's Criterion, Fatigue design using Miner's equation, Problems.

UNIT-II

Springs, Joints & Drives: Types of springs, Design for helical springs against tension and their uses, compression and fluctuating loads, Surging phenomenon in springs, design of cotter and knuckle joints, Design of belt drives, Flat & V-belt drives Design Problem

UNIT-III

Bearings : Selection of ball and roller bearing based on static and dynamic load carrying capacity using load-life relationship, Selection of Bearings from manufacturer's catalogue, Selection of suitable lubricants, Design Problems.

Keys, Clutches & Brakes: Flat, Kennedy Keys, Splines, Couplings design – Rigid & Flexible coupling, turning Moment diagram, coefficient of fluctuation of energy and speed, various types of clutches in use, Design of friction clutches – Single disc, Multidisc, Cone & Centrifugal, Torque transmitting capacity. Various types of Brakes, Self energizing condition of brakes, Design of shoe brakes – Internal & external expanding, band brakes, Thermal Considerations in brake designing.

UNIT-IV

Gears: Classification, Selection of gears, Terminology of gears, Force analysis, Selection of material for gears, Beam & wear strength of gear tooth, Buckingham equation, Design of spur, helical, bevel including the Consideration for maximum power transmitting capacity, Gear Lubrication, Design Problems.

Text and Reference Books

1. Mechanical Engg. Design - First Metric Editions: Joseph Edward Shigley-MGH, New York.
2. Design of Machine Elements – V.B. Bhandari – Tata McGraw Hill, New Delhi.
3. Machine Design an Integrated Approach: Robert L.Norton, Addison Wesley.
4. Machine Design: S.G. Kulkarini - Tata MacGraw Hill.
5. Design of machine elements-C S Sharma, Kamlesh Purohit, PHI.
6. PSG Design Data Book

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	--	--	--	--	--	1	--	3	2	2	--
CO2	3	2	1	3	--	1	--	2	3	2	2	3	3	2	2
CO3	3	2	2	3	--	--	--	2	1	1	--	2	2	2	2
CO4	3	2	2	3	3	1	--	2	2	3	2	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

INDUSTRIAL TRAINING PRESENTATION-I

General Course Information

Course Code: PROJ-ME301-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal:100)**Internal continuous assessment of 100 marks on the basis of report writing, presentation and viva voce in practical classes by the team of panel of faculty members.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to get the exposure of 'real' working environment and get acquainted with the organization structure, business operations and administrative functions.	L1
CO2	Students will be able to demonstrate competency in relevant engineering fields through problem identification, formulation and solution.	L2
CO3	Students will be able to develop the ability to work as an individual and in group with the capacity to be a leader as well as an effective team member.	L3
CO4	Students will be able to generate a report based on the experiences with the ability to apply knowledge of Engineering fundamentals	L4
CO5	Students will be master in his profession and perform ethical responsibilities of an engineer	L5

Course Contents

As a part of the B. Tech. Mechanical Engineering Curriculum Industrial Training-I is a Practical course, which the students of Mechanical Engineering should undergo in reputed Private / Public Sector / Government organization / companies as industrial training of four-six weeks in the summer vacation after the IV semester.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	--	--	--	2	2	--	--	--	2	3	3	3	3
CO2	3	3	3	3	3	--	--	--	--	2	--	2	2	2	2
CO3	--	--	--	--	--	--	--	2	3	--	--	--	--	--	2
CO4	3	--	--	--	--	--	--	--	--	3	--	2	--	--	2
CO5	--	--	--	--	--	1	--	3	--	2	2	2	2	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

TECHNICAL PRESENTATION

General Course Information

Course Code: MC-ME301-P Course Category: Mandatory Course Course Credits: 0.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods(Internal: 100):** This is a **non-credit course of qualifying nature**. Internal practical evaluation is to be done by the course coordinator.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to read and understand recent trends and technologies in the field of Mechanical Engineering	L1
CO2	Students will be able to prepare concise, comprehend and conclude selective topic in the field of Mechanical Engineering	L2
CO3	Students will be able to develop skills in presentation and discussion of research topics in a public forum	L3
CO4	Students will be able to formulate innovative ideas in the field of engineering	L4

Course Contents

The students are required to give power point presentation on the topic related to current research area in the field of Mechanical Engineering. The presentation should be held in the class room/ seminar hall in presence of the course coordinator

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	--	--	--	--	--	--	2	2	3	--	2
CO2	3	1	2	2	--	--	--	--	--	2	--	2	2	--	--
CO3	--	--	--	--	--	--	--	--	--	3	--	2	--	--	--
CO4	3	2	2	2	--	--	--	--	--	2	--	2	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

6th Semester

DYNAMICS OF MACHINES (THEORY)

General Course Information

Course Code: PCC-ME305-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the various mechanical systems like flywheel, transmission drives, governor, gyroscope, brake, dynamometer and balancing, and state forces and their effect acting on them, and fundamental laws of dynamics.	L1
CO2	Students will be able to describe different mechanical systems and their dynamic behaviour.	L2
CO3	Students will be able to solve different kind of problems related to force analysis in different mechanical systems.	L3
CO4	Students will be able to analyse different mechanical systems dynamically.	L4
CO5	Students will be able to select and design appropriate mechanical system required for a particular application.	L5

Course Contents

UNIT-I

Flywheel: Turning Moment Diagrams, Fluctuation of Energy, Coefficient of Fluctuation of Energy and Speed, Application in Engines and Punching Presses, Problems

Belts, Ropes and Chain Drives: Types of Belt Drives, Velocity Ratio, Slip, Belt Length, Crowning of Pulleys, V-Belts, Condition for Transmission of Maximum Power, Centrifugal Tension, Chain Drive, Types of Chains, Merits and Demerits of Chain Drive over Belt Drive, Problems

UNIT-II

Governors: Governor, Types of Governors, Centrifugal Governors, Watt Governor, Porter Governor, Proell Governor, Hartnell Governor, Hartung Governor, Wilson- Hartnell Governor, Pickering Governor, Sensitiveness of Governors, Stability of Governors, Hunting of Governors, Effort and Power of a Governor, Problems

Gyroscope: Gyroscope, Gyroscopic Couple, Gyroscopic Stabilization of Aeroplane and Ship, Stability of Four Wheel and Two Wheel Vehicles Moving on Curved Path, Problems

UNIT-III

Brakes: Brake, Types of Brakes, Block or Shoe Brake, Band Brake, Differential Band Brake, Band and Block Brake, Internal Expanding Shoe Brake, Braking Effect in a Vehicle, Problems

Dynamometers: Dynamometer, Types of Dynamometers, Prony Brake Dynamometer, Rope Brake Dynamometer, Epicyclic Train Dynamometer, Belt Transmission Dynamometer, Torsion Dynamometer, Problems

UNIT-IV

Balancing of Rotating Parts: Static Balancing, Dynamic Balancing, Balancing of Rotating Masses, Balancing of Several Masses Rotating in Same Plane by Graphical Method, Balancing of Several Masses Rotating in Different Planes by Graphical Method, Problems

Balancing of Reciprocating Parts: Balancing of Reciprocating Masses, Partial Balancing of Locomotives, Effect of Partial Balancing of Reciprocating Parts of Two Cylinder Locomotives, Balancing of Multi Cylinder Inline Engines, Radial Engines and V- Engines, Problems

Text and Reference Books

1. KJ, Waldron and GL, Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley Publishers, Edition, 2016.
2. A, Ghosh and AK, Mallik, Theory of Mechanisms and Machines, East West Press Private Limited Publishers, Edition, 2017.
3. JJ, Uicker (Jr), GR, Pennock and JE, Shigley, Theory of Machines and Mechanisms, Oxford Publishers, 2016.
4. SS, Rattan, Theory of Machines, Tata McGraw Hill Publishers, Edition, 2017.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

DYNAMICS OF MACHINE (LAB)

General Course Information

Course Code: PCC-ME305-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the various mechanical systems like flywheel, transmission drives, governor, gyroscope, brake, dynamometer, balancing.	L1
CO2	Students will be able to describe different mechanical systems through models and experimental setups.	L2
CO3	Students will be able to solve different kind of problems related to force analysis in different mechanical systems experimentally.	L3
CO4	Students will be able to analyse dynamically and determine the parameters involved in the various mechanical systems experimentally.	L4
CO5	Students will be able to select and design appropriate mechanical system required for a particular application.	L5

Lab Contents

1. To perform experiment on Watt Governor, to Prepare Performance Characteristic Curves, and to find stability and sensitivity.
2. To Perform Experiment on Porter Governor, to Prepare Performance Characteristic Curves, and to Find Stability and Sensitivity.
3. To Perform Experiment on Proell Governor, to Prepare Performance Characteristic Curves, and to Find Stability and Sensitivity.
4. To Perform Experiment on Hartnell Governor, to Prepare Performance Characteristic Curves, and to Find Stability and Sensitivity.
5. To Study Gyroscopic Effects Through Models.
6. To Determine Gyroscopic Couple on Motorized Gyroscope.
7. To Perform the Experiment for Static Balancing on Static Balancing Machine.
8. To Perform the Experiment for Dynamic Balancing on Dynamic Balancing Machine.
9. Determine the Moment of Inertial of Connecting Rod by Compound Pendulum Method and Triflair Suspension Pendulum.
10. To Find BHP of an Engine by Using Rope Brake Dynamometer.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

AUTOMOBILE ENGINEERING (THEORY)

General Course Information

Course Code: PCC-ME306-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the basic components of an automobile.	L1
CO2	Students will be able to explain the functions of all the basic components of an automobile.	L2
CO3	Students will be able to demonstrate the working of an automobile.	L3
CO4	Students will be able to examine the conditions of an automobile.	L4
CO5	Students will be able to evaluate the overall vehicle performance of an automobile.	L5

Course Contents

UNIT-I

Introduction to Automobiles : Classification, Components, Requirements of Automobile Body; Vehicle Frame, Separate Body & Frame, Unitized Body, Car Body Styles, Bus Body & Commercial Vehicle Body Types; Front Engine Rear Drive & Front Engine Front Drive Vehicles, Four Wheel Drive Vehicles, Safety considerations; Safety features of latest vehicle; Future trends in automobiles.

Clutches : Requirement of Clutches – Principle of Friction Clutch – Wet Type & Dry Types; Cone Clutch, Single Plate Clutch, Diaphragm Spring Clutch, Multi plate Clutch, Centrifugal Clutches, Electromagnetic Clutch, Over Running Clutch; Clutch Linkages.

UNIT-II

Power Transmission: Requirements of transmission system; General Arrangement of Power Transmission system; Object of the Gear Box; Different types of Gear Boxes; Sliding Mesh, Constant Mesh, Synchro- mesh Gear Boxes; Epi-cyclic Gear Box, Freewheel Unit. Overdrive unit-Principle of Overdrive, Advantage of Overdrive, Transaxle, Transfer cases.

Drive Lines, Universal Joint, Differential and Drive Axles: Effect of driving thrust and torque reactions; Hotchkiss Drive, Torque Tube Drive and radius Rods; Propeller Shaft, Universal Joints, Slip Joint; Constant Velocity Universal Joints; Front Wheel Drive; Principle, Function, Construction & Operation of Differential; Rear Axles, Types of load coming on Rear Axles, Full Floating, Three quarter Floating and Semi Floating Rear Axles.

UNIT-III

Suspension Systems: Need of Suspension System, Types of Suspension; factors influencing ride comfort, Suspension Spring; Constructional details and characteristics of leaf springs.

Steering System : Front Wheel geometry & Wheel alignment viz. Caster, Camber, King pin Inclination, Toe-in/Toe-out; Conditions for true rolling motions of Wheels during steering; Different types of Steering Gear Boxes; Steering linkages and layout; Power steering – Rack & Pinion Power Steering Gear, Electronics steering.

UNIT-IV

Automotive Brakes, Tyres & Wheels : Classification of Brakes; Principle and constructional details of Drum Brakes, Disc Brakes; Brake actuating systems; Mechanical, Hydraulic, Pneumatic Brakes; Factors affecting Brake performance, Power & Power Assisted Brakes; Tyres of Wheels; Types of Tyre & theirconstructional details, Wheel Balancing, Tyre Rotation; Types of Tyre wear & their causes.

Emission Control System & Automotive Electrical : Sources of Atmospheric Pollution from the automobile, Emission Control Systems – Construction and Operation of Positive Crank Case Ventilation (PVC) Systems, Evaporative Emission Control, Heated Air Intake System, Exhaust Gas Recirculation (ECR) Systems, Air Injection System and Catalytic Converters; Purpose construction & operation of lead acid Battery, Capacity Rating & Maintenance of Batteries; Purpose and Operation of Charging Systems, Purpose and Operations of the Starting System; Vehicle Lighting System.

Text and Reference Books

1. Automobile Engineering by Anil Chhikara, Satya Prakashan, New Delhi.
2. Automobile Engineering by Dr. Kirpal Singh, standard Publishers Distributors.
3. Automotive Mechanics – Crouse / Anglin, TMH.
4. Automotive Technology – H.M. Sethi, TMH, New Delhi.
5. Automotive Mechanics – S.Srinivasan, TMH, New Delhi.
6. Automotive Mechanics – Joseph Heitner, EWP.
7. Motor Automotive Technology by Anthony E. Schwaller – Delmer Publishers, Inc.
8. The Motor Vehicle – Newton steeds Garrett, Butter Worths.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	1	1	1	1	1	1	3	3	3	1
CO2	3	3	3	2	--	1	1	1	1	1	1	3	3	3	1
CO3	3	3	3	2	--	1	2	1	1	1	1	3	3	3	2
CO4	3	3	3	3	--	1	3	2	1	1	1	3	3	3	3
CO5	3	3	3	3	--	1	3	2	1	1	1	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

AUTOMOBILE ENGINEERING (LAB)

General Course Information

Course Code: PCC-ME306-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to list the basic components required for an automobile.	L1
CO2	Students will be able to prepare a report on the constructional details, working principles and operation of different components of an automobile.	L2
CO3	Students will be able to demonstrate the function of basic components used in an automobile.	L3
CO4	Students will be able to differentiate the performance of different components used in an automobile.	L4
CO5	Students will be able to select the most suitable component form the available to improve the performance of an automobile.	L5

Lab Contents

1. To study and prepare report on the constructional details, working principles and operation of the following Automotive Engine Systems & Sub Systems.
    a. Multi-cylinder: Diesel and Petrol Engines.
    b. Engine cooling & lubricating Systems.
    c. Engine starting Systems.
    d. Contact Point & Electronic Ignition Systems.
2. To study and prepare report on the constructional details, working principles and operation of the following Fuels supply systems:
    a. Carburetors
    b. Diesel Fuel Injection Systems
    c. Gasoline Fuel Injection Systems.
3. To study and prepare report on the constructional details, working principles and operation of the following Automotive Clutches.
    a. Coil-Spring Clutch
    b. Diaphragm – Spring Clutch.
    c. Double Disk Clutch.
4. To study and prepare report on the constructional details, working principles and operation of the following Automotive Transmission systems.
    a. Synchromesh – Four speed Range.
    b. Transaxle with Dual Speed Range.
    c. Four Wheel Drive and Transfer Case.
    d. Steering Column and Floor – Shift levers.
5. To study and prepare report on the constructional details, working principles and operation of the following Automotive Drive Lines & Differentials.
    a. Rear Wheel Drive Line.
    b. Front Wheel Drive Line.
    c. Differentials, Drive Axles and Four Wheel Drive Line.
6. To study and prepare report on the constructional details, working principles and operation of the following Automotive Suspension Systems.
    a. Front Suspension System.
    b. Rear Suspension System.

7. To study and prepare report on the constructional details, working principles and operation of the following Automotive Steering Systems.
    a. Manual Steering Systems, e.g. Pitman –arm steering, Rack & Pinion steering.
    b. Power steering Systems, e.g. Rack and Pinion Power Steering System.
    c. Steering Wheels and Columns e.g. Tilt & Telescopic steering Wheels, Collapsible Steering Columns.
8. To study and prepare report on the constructional details, working principles and operation of the following Automotive Tyres & wheels.
    a. Various Types of Bias & Radial Tyres.
    b. Various Types of wheels.
9. To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems.
    a. Hydraulic & Pneumatic Brake systems.
    b. Drum Brake System.
    c. Disk Brake System.
    d. Antilock Brake System.
    e. System Packing & Other Brakes.
10. To study and prepare report on the constructional details, working principles and operation of Automotive Emission / Pollution control systems.
11. Modeling of any two automotive systems on 3D CAD using educational softwares (eg. 3D modeling package/Pro Engineering/I-Deas/ Solid edge etc.)
12. Crash worthiness of the designed frame using Hypermesh and LS-Dyna solver or other software.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	--	2	2	1	1	1	1	3	3	3	1
CO2	3	3	3	1	--	2	2	1	1	1	1	3	3	3	1
CO3	3	3	3	1	--	2	2	1	1	2	1	3	3	3	1
CO4	3	3	3	1	--	3	3	2	2	2	2	3	3	3	3
CO5	3	3	3	1	--	3	3	2	2	2	2	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

HEAT TRANSFER (THEORY)

General Course Information

Course Code: PCC-ME307-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorial Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and relate different modes of heat transfer.	L1
CO2	Students will be able to describe, explain and compare the mechanisms of heat transfer.	L2
CO3	Students will be able to apply the basic principles of heat transfer in daily routine thermal systems and can demonstrate its working.	L3
CO4	Students will be able to examine and compare the operations of various heat transfer devices.	L4
CO5	Students will be able to evaluate the performance of various heat transfer devices.	L5
CO6	Students will be able to design and select a better heat exchanging/transfer device under given conditions.	L6

Course Contents

UNIT-I

Basics and Laws: Definition of Heat Transfer, Reversible and irreversible processes, Modes of heat flow, Combined heat transfer system and law of energy conservation.

Steady State Heat Conduction: Introduction, I-D heat conduction through a plane wall, long hollow cylinder, hollow sphere and Conduction equation in Cartesian, polar and spherical co-ordinate systems, Numericals.

UNIT-II

Steady State Conduction with Heat Generation: Introduction, 1 – D heat conduction with heat sources, Extended surfaces (fins), Fin effectiveness, Numericals.

Transient Heat Conduction: Systems with negligible internal resistance, Transient heat conduction in plane walls, cylinders, spheres with convective boundary conditions, Numericals.

UNIT-III

Convection: Forced convection-Thermal and hydro-dynamic boundary layers, Equation of continuity, Momentum and energy equations, Some results for flow over a flat plate and flow through tube, Fluid friction and heat transfer (Colburn analogy), Free convection from a vertical flat plate, Empirical relations for free convection from vertical and horizontal planes, Numericals.

Thermal Radiation: The Stephen-Boltzmann law, black body radiation, Shape factors and their relationships, Heat exchange between non black bodies, Electrical network for radiative exchange in an enclosure of two or three gray bodies, Radiation shields, Numericals.

UNIT-IV

Heat Exchangers: Classification, Performance variables, Analysis of a parallel/counter flow heat exchanger, Heat exchanger effectiveness, Numericals.

Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling regimes, Free convective, Nucleate and film boiling, Numericals.

Text and reference Books

1. Heat and Mass Transfer: Fundamentals and Application, Yunus A Cengel; Afshin J. Ghajar, Mc Graw Hill
2. Heat Transfer – J.P. Holman, John Wiley & Sons, New York.
3. Fundamentals of Heat & Mass Transfer–Incropera, F.P. & Dewitt, D.P –John Willey New York.
4. Conduction of Heat in Solids – Carslow, H.S. and J.C. Jaeger – Oxford Univ. Press.
5. Conduction Heat Transfer – Arpasi, V.S. – Addison – Wesley.
6. Compact Heat Exchangers – W.M. Keys & A.L. Landon, Mc. Graw Hill.
7. Thermal Radiation Heat Transfer – Cengel, R. and J.R. Howell, Mc. Graw Hill.
8. Heat Transmission – W.M., Mc.Adams , Mc Graw Hill.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	--	2	1	1	1	2	1	2	3	3	1
CO2	3	3	2	1	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	2
CO6	3	3	3	3	--	2	2	2	2	2	2	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

HEAT TRANSFER (LAB)

General Course Information

Course Code: PCC-ME307-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and relate different modes of heat transfer.	L1
CO2	Students will be able to describe, explain and compare the mechanisms of heat transfer.	L2
CO3	Students will be able to apply the basic principles of heat transfer in daily routine thermal systems and can demonstrate its working.	L3
CO4	Students will be able to examine and compare the operations of various heat transfer devices.	L4
CO5	Students will be able to evaluate the performance of various heat transfer devices.	L5
CO6	Students will be able to design and select a better heat exchanging/transfer device under given conditions.	L6

Lab Contents

1. To determine the thermal conductivity of a metallic rod.
2. To determine the thermal conductivity of an insulating power.
3. To determine the thermal conductivity of a solid by the guarded hot plate method.
4. To find the effectiveness of a pin fin in a rectangular duct natural convective condition and plot temperature distribution along its length.
5. To find the effectiveness of a pin fin in a rectangular duct under forced convective and plot temperature distribution along its length.
6. To determine the surface heat transfer coefficient for a heated vertical tube under natural convection and plot the variation of local heat transfer coefficient along the length of the tube. Also compare the results with those of the correlation.
7. To determine average heat transfer coefficient for externally heated horizontal pipe under forced convection & plot Reynolds and Nusselt numbers along the length of pipe. Also compare the results with those of the correlations.
8. To measure the emissivity of the gray body (plate) at different temperature and plot the variation of emissivity with surface temperature.
9. To find overall heat transfer coefficient and effectiveness of a heat exchange under parallel and counter flow conditions. Also plot the temperature distribution in both the cases along the length of heat of heat exchanger.
10. To verify the Stefen-Boltzmann constant for thermal radiation.
11. To demonstrate the super thermal conducting heat pipe and compare its working with that of the best conductor i.e. copper pipe. Also plot temperature variation along the length with time or three pipes.
12. To study the two phases heat transfer unit.
13. To determine the water side overall heat transfer coefficient on a cross-flow heat exchanger.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO2	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO3	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	2	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	1
CO6	3	3	3	2	--	2	1	1	2	2	2	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

ENTREPRENEURSHIP (THEORY)

General Course Information

Course Code: MC-ME302-T Course Category: Mandatory Course Course Credits: 0.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe the concept of entrepreneurship, the role of entrepreneurship in economic development of the country and the scope for an entrepreneur	L1
CO2	Students will be able to understand small enterprises, problems faced by small enterprises, engineering economics, product planning and development, the contents of a project report and formulation of a project report.	L2
CO3	Students will be able to apply the basic steps in setup a new business.	L3
CO4	Students will be able to examine the development of a startup.	L4

Course Contents

Unit – I

Entrepreneurship: Entrepreneurship, Role of entrepreneur in Indian economy, Characteristics of all entrepreneur, Types of entrepreneurs, some myths and realities about entrepreneurship.

Small scale Industries: Introduction, Role and scope of small scale industries, concept of small scale and ancillary industrial undertaking, How to start a small scale industry, Steps in launching own venture, procedure for registration of small scale industries, various development agencies- their functions and role in industrial and entrepreneurship development, Infrastructure facilities available for entrepreneurship development in India.

Unit – II

Engineering Economics: Definition and concept, Importance of Economics for engineers, present value, Wealth, Goods, Wants, Value and price, capital, money, utility of consumer and producer goods.

Costing: Introduction, Elements of cost, Prime cost, Overhead, Factory cost, Total cost, Selling Price, Nature of cost, Types of Cost.

Unit III

Depreciation: Definition and concept, Causes of Depreciation, Methods of calculating depreciation.

Economic analysis of investment: Introduction, Nature of selection problem, Nature of replacement problem, Replacement of items which deteriorate, Replacement of machines whose operating cost increase with time and the value of money also changes with time

Unit IV

Product planning and Development: Introduction, Requirement of a good product design, product development approaches, Product development process, Elements of concurrent engineering, Various controlling agencies involved their role and formalities for getting clearance before starting individual venture.

Preparation of feasibility Project Report: Tools for evaluation of techno-economic feasibility project report, Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information, SWOT analysis.

Text and reference Books

1. The practice of Entrepreneurship - G.G. Meredikh, R.E. Nelson and P.A. Neck
2. Handbook of Entrepreneurship - Rao and Pareek
3. S.S.Khanka "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999.
4. Kuratko & Hodgetts, "Enterprenuership – Theory, process and practices", Thomson learning 6th edition.
5. Hisrich R D and Peters M P, "Entrepreneurship" 5th Edition Tata McGraw-Hill, 2002
6. Mathew J Manimala," Enterprenuership theory at cross roads: paradigms and praxis" Dream tech 2nd edition 2006.88
7. Rabindra N. Kanungo "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	1	--	--	2	--	--	--	3	3	3	1	2	1
CO2	2	1	1	--	2	2	--	--	2	2	3	3	--	2	2
CO3	--	2	2	2	2	2	1	--	2	2	3	3	--	1	1
CO4	--	--	--	--	1	1	--	--	2	2	3	3	--	1	--

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -I

Course Code	Course Name	L	T	P	Credits
PEC-ME351-T	Operation Research	3	-	-	3.0
PEC-ME352-T	Work Study	3	-	-	3.0
PEC-ME353-T	Total Quality Control	3	-	-	3.0
PEC-ME354-T	Production Management	3	-	-	3.0
PEC-ME355-T	Industrial Engineering	3	-	-	3.0

OPERATION RESEARCH (THEORY)

General Course Information

Course Code: PEC-ME351-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the concept of operation research	L1
CO2	Students will be able to learn the principles of linear programming problems and their applications	L2
CO3	Students will be able to apply the principles of transportation problems and assignment problems.	L3
CO4	Students will be able to formulate the OR models for various needs of the society and organization.	L4
CO5	Students will be able to solve the problems of society and organization using OR techniques.	L5

Course Contents

Unit - I

Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods.

Linear Programming (LP): Programming definition, formulation, solution- graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M methods computational, problems.

Unit - II

Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

Advanced Topic Of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

Unit - III

Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems.

Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.

Unit - IV

Simulation: Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems.

Decision Theory: Decision process, SIMON model types of decision making environment- certainty, risk, uncertainty, decision making with utilities, problems.

Text and Reference Books

1. Operation Research – Hira, D.S.
2. Operation Research – TAHA, PHI, New Delhi.
3. Principle of Operations Research – Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.
4. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
5. Quantitative Techniques- Vohra, TMH, New Delhi
6. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice Hall of India, New Delhi.
7. Operation Research – Sharma, Gupta, Wiley Eastern, New Delhi.
8. Operation Research – Philips, Revindran, Solgeberg, Wiley ISE.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	--	2	1	1	1	2	1	2	3	3	1
CO2	3	3	2	1	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

WORK STUDY (THEORY)

General Course Information

Course Code: PEC-ME352-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the concepts of work study and its application area.	L1
CO2	Student will be able to apply different types of engineering work methods with the help of charting and diagrams to eliminate unproductive activities under the different controls in operations and job analysis.	L2
CO3	Student will be able to record the activities of the people, materials and equipment to find alternative methods which minimize waste and to implement the devised method.	L3
CO4	Student will be able to find the standard time of any activity through work measurement techniques with the aim to improve the processes.	L4
CO5	Student will be able to design to the man–machine system ergonomically to improve Human Efficiency and reduce the effort of the workers	L5

Course Contents

Unit – I

Work Study: Definition and Objective of Work Study, Scope of Work Study, Advantages of Work Study, Techniques of Work Study, Work Study and Management, Work Study and Productivity

Unit – II

Method Study: Objectives and Procedure of Method Study, Selection of job, Various recording techniques like outline process charts, flow process charts, man machine charts, two handed process charts, string diagram, flow diagram, multiple activity chart, SIMO chart and micro motion study, cyclographs and chrono-cyclographs, Process Chart Symbols, Therblig

Unit- III

Work Measurement: Definition and Objectives of Work Measurement, Work measurement techniques, basic procedure of work measurement.

Time Study: Definition of Time Study, Difference between Time Study and Motion Study, Basic Procedure for Time Study, Time study equipment, Job evaluation and incentive schemes Various Time Estimates and Production Standard, Level of Performances, Allowances, allowances and standard time determination

Unit – IV

Ergonomics: Concept of Ergonomics, Objectives of Ergonomics, Man Machine System Interface, Anthropometry, Ergonomics and Safety, Fatigue in Workers, Quantitative qualitative representation and alphanumeric displays, control

types, relation between controls and displays, Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.

Text and Reference Books

1. Work study and Ergonomics by Suresh Dalela and Saurabh, Standard Publishers
2. Motion and Time Study by R. M. Bernes, John-Wiley & Sons, 2001.
3. Ergonomics at work by D.J. Oborne, John Wiley & Sons
4. Human Factors in Engineering and Design by Sanders Mark S and McCormick Ernert J, McGraw-Hill Inc., 1993.
5. International Labour organization, "Work-study", Oxford and IBH publishing company Pvt. Ltd., N.Delhi, 2001

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO2	3	3	2	1	2	1	1	2	2	2	2	2	2	3	3
CO3	3	3	2	1	2	1	1	2	2	2	2	2	2	3	3
CO4	3	3	2	1	2	1	1	2	2	2	2	2	2	3	3
CO5	3	3	2	1	2	1	1	2	2	2	2	2	2	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

TOTAL QUALITY CONTROL (THEORY)

General Course Information

Course Code: PEC-ME353-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the philosophy and core values of Total Quality Control	L1
CO2	Student will be able to learn about the statistical quality control in production and apply the knowledge of control charts for monitoring the quality of process/product	L2
CO3	Student will be able to understand the standard sampling plans, learn the rejection process for a product in an industry.	L3
CO4	Student will be able to understand the different quality standards in industry.	L4

Course Contents

UNIT-I

Quality Control: Introduction, objectives, quality of design, quality of production, quality of conformance to design, quality of inspection, process monitoring, quality and productivity, quality cost. Advantages of Statistical Quality Control in Industry.

Fundamentals of Statistics and Probability in Quality Control: Events and probability, laws of probability. Statistical Distributions: Normal, Binomial and Poisson distribution, their importance in SQC. Poisson Probability as approximation to Normal Probability, use of Normal and Poisson distribution tables.

UNIT-II

Control Charts for Variables: Fundamentals of process control, tools of process control, quality characteristic, Design and use of Control Charts for Variables: Trial control limits, control limits for future use, revision of control limits. Cause and effect diagram, inferences on the state of the process from control charts, Type I and Type II errors and methods to reduce them. Use of X (X bar) charts and R- charts, X (X bar) and σ- charts. Efficiency of a control chart. OC curve of a control chart. Computing average run length for X- chart.

Trend Control Charts: Control Charts with Reject Limits and Modified Control Charts. Relationship between Specification Limits and Control Chart Limits, Process capability analysis and its importance in quality of conformance.

UNIT-III

Control Charts for Attributes: Defects and Defectives, control charts for fraction defectives and percent fraction defectives and number of defectives. Control charts for number of defects. Comparison of control charts for variables with the charts for attributes. Computing Average run length for a p-chart.

Product Control and its Tools: Fundamentals of lot-by-lot acceptance sampling by attributes: Notations, OC curve and its importance in acceptance sampling, AQL and LTPD for a sampling plan, Producer and consumer risks, Single and Double sampling plans and constructing OC curves, interpretation of the operating characteristics curve, Effect of change of sample size and acceptance number on OC curve, ATI, ASN, AOQ and AOQL concepts, economics of inspection. Item- by- item sequential sampling plans, OC curve and ASN curve for sequential sampling plan.

UNIT-IV

Standard Sampling Plans: Types of Standard Sampling Plans, Difference between Acceptance Rectification and Acceptance- Rejection Plans, single and double sampling plans based on AOQL and LTPD. Sampling plans based on Mil-Standards 105 E.

Motivation for quality assurance, zero defect program, quality circles, total quality management. Indian Standards on Process and Product Control. ISO-9000 Standards.

Text and Reference Books

1. Quality control Application – By Hansen BL, Ghare PH; Prentice Hall of India.
2. Statistical Quality Control - By E.L. Grant & R.S. Levenworth; T MH.
3. Quality Control – Paranthaman, D.; Tata McGraw Hill, India
4. Quality Planning and Analysis – Juran J.M. and F.M. Gryna, TMH, India
5. Total Quality Control – By Feigenbaum, A.V.; McGraw Hill International.
6. Statistical Quality Control – By Montgomery, D.C.; John Wiley & Sons (Asia)

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO2	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO3	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO4	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

PRODUCTION MANAGEMENT (THEORY)

General Course Information

Course Code: PEC-ME354-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods and Management effectively.	L1
CO2	Student will be able to understand the forecasting and material handling concepts.	L2
CO3	Student will be able to understand material management and learn different purchasing methods.	L3
CO4	Student will be able to understand the role of Production planning & control and implementation of Just in time technique in Production management.	L4
CO5	Student will be able to understand the Quality control and apply the control charts in Production management.	L5

Course Contents

UNIT-I

Introduction to Production Management- Introduction, History of Production Management, Definitions of Production Management, Objectives of Production Management, Scope of Production Management.

Forecasting- Purpose of sale forecasting, Importance of forecasting, Forecasting and Product life cycle, Forecasting methods, Qualitative and Quantitative techniques of forecasting.

UNIT-II

Material handling- Objectives and Principles of material handling, Relation between plant layout and material handling, Material handling equipments and their effective utilisation.

Material Management- Material planning and control, Purchasing methods, Purchasing procedure, inventory control, stores management and coding, inventory control, Material requirement planning (MRP).

UNIT-III

Production planning and control- Objectives and need for Production planning and control, Operations scheduling, Aggregate planning, Master production schedule (MPS).

Quality control- Quality and inspection, Seven tools for Quality control, Control charts, Acceptance sampling, Quality circles.

UNIT-IV

Man power and facilities planning- Man power requirement and planning, Plant Heuristics, Facilities requirement and planning, Role of advanced process planning.

Just in Time (JIT)- Introduction and characteristics of JIT, Benefits of JIT, Implementation of JIT, Processes to eliminate waste, JIT inventory.

Text and Reference Books

1. S.Anil Kumar & N.Suresh, "Production and operations Management", New Age International.
2. Buffa & Sarin, "Modern Production Management", John Wiley Publication
3. M.Mahajan., "Statistical Quality Control", Dhanpat Rai Publication.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO2	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO3	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO4	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO5	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

INDUSTRIAL ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME355-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods and Management effectively.	L1
CO2	Student will be able to apply work study methods with the help of charting and diagrams to eliminate unproductive activities in different operations and job analysis.	L2
CO3	Student will be able to record the activities of the people, materials and equipment to find alternative methods which minimize waste and also to find the Standard Time of any activity through work measurement techniques.	L3
CO4	Student will be able to understand the need of ergonomics in Man–Machine Interface, Human Efficiency and the effort of the workers	L4
CO5	Student will be able to understand the concepts of value engineering and intellectual property rights	L5

Course Contents

UNIT-I

Plant Layout: Objectives of Good Plant Layout, Importance of Plant Layout, Types of Plant Layout, Advantages and Limitations of Different Types of Plant Layouts

Material Handling: Function of Material Handling, Principles of Material Handling, Material Handling Devices, Relation between Plant Layout and Material Handling

UNIT-II

Work Study: Definition and Concept of Work Study, Need of Work Study, Advantages of Work Study, Techniques of Work Study, Work Study and Management, Work Study and Productivity

Method Study: Objectives and Procedure of Method Study, Process Chart Symbols, Flow Diagram, String Diagram, Therblig, Multiactivity Charts

UNIT-III

Work Measurement: Objectives of Work Measurement, Basic Procedure for Time Study, Difference between Time Study and Motion Study, Various Time Estimates and Production Standard, Level of Performances, Allowances, Various Time Recording Techniques in Time Study

Value Engineering: Types of Values, Concept of Value Engineering, Phases of Value Engineering Studies, Application of Value Engineering

UNIT-IV

Ergonomics: Concept of Ergonomics, Objectives of Ergonomics, Man Machine System Interface, Anthropometry, Ergonomics and Safety, Ergonomics and Fatigue

Intellectual Property Rights: Intellectual Property Rights, Patents, Trade Marks, CopyRights, Law of Contract

Text and Reference Books

1. Industrial Engineering and Management by Hicks, Tata McGraw Hill, New Delhi
2. Work study and Ergonomics by Suresh Dalela and Saurabh, Standard Publishers
3. Motion and time study by R. Bernes, John-Wiley & Sons
4. Ergonomics at work by D.J. Oborne, John Wiley & Sons
5. Techniques of Value Analysis and Engineering by Miles, McGraw Hill

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO2	3	3	2	1	2	1	1	2	2	2	2	2	2	3	3
CO3	3	3	2	1	2	1	1	2	2	2	2	2	2	3	3
CO4	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3
CO5	1	1	1	1	2	2	2	1	1	1	3	2	1	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

7th Semester

REFRIGERATION AND AIR-CONDITIONING (THEORY)

General Course Information

Course Code: PEC-ME401-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorial Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to describe about the refrigeration, air-conditioning, refrigerant and applications of refrigeration systems.	L1
CO2	Student will be able to identify the main components, accessories and controls of refrigeration and air-conditioning systems.	L2
CO3	Student will be able to solve the air-conditioning problem using the principles of psychrometry.	L3
CO4	Student will be able to analyze the performance of vapour compression and other refrigeration system.	L4
CO5	Student will be able to select a refrigeration/air-conditioning according to the comfort conditions.	L5
CO6	Student will be able to design transmission of air in air conditioning system through various types of ducts and design methods	L6

Course Contents

Unit – I

Introduction: Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system; Refrigerants- Definition, Classification, Nomenclature, Desirable properties, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics.

Air Refrigeration System: Carnot refrigeration cycle, Brayton refrigeration or the Bell Coleman air refrigeration cycle; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems, problems.

Unit – II

Vapour Compression (VC) Refrigeration Systems:(A) Simple Vapour Compression (VC) Refrigeration Systems, Limitations of Reversed Carnot cycle; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP; Comparison of VC cycle with Air Refrigeration cycle.

(B) Multistage Refrigeration Systems- Necessity of compound compression, Compound VC cycle, Inter-cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter-cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers.

Other Refrigeration Systems:(A) Vapour Absorption Refrigeration Systems – Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Problems.
(B) Steam Jet Refrigerating System- Introduction, Analysis, Relative merits and demerits, Performance Applications, Problems.

Unit – III

Psychrometry of Air & Air Conditioning Processes: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer, Problems.

Air- Conditioning Load Calculations: Outside and inside design conditions; Sources of heating load; Sources of cooling load; Heat transfer through structure, Solar radiation, Electrical applications, Infiltration and ventilation, Heat generation inside conditioned space; Apparatus selection; Comfort chart, Problems.

Unit – IV

Air Conditioning Systems with Controls & Accessories: Classifications, Layout of plants; Equipment selection; Air distribution system; Duct systems Design; Filters; Refrigerant piping; Design of summer air-conditioning and Winter air conditioning systems; Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls; Accessories; Problems.

Refrigeration and Air Conditioning Equipments: Type of compressors and their performance curves; Types of Condensers, Heat transfer in condensers; Types of expansion devices; types of evaporators, Cooling and Dehumidifying coils, Problems.

Text and Reference Books

1. Refrigeration & Air conditioning –R.C. Jordan and G.B. Priester, Prentice Hall of India.
2. Refrigeration & Air conditioning –C.P. Arora, TMH, New Delhi.
3. A course in Refrigeration & Air Conditioning – Arora & Domkundwar, Dhanpat Rai & Sons.
4. Refrigeration & Air conditioning –W.F. Stocker and J.W. Jones, TMH, New Delhi.
5. Refrigeration & Air conditioning- Manohar Prasad Wiley Estern limited, New Delhi.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	2	1	--	--	2	1	3	3	2	1
CO2	3	1	1	1	--	2	1	--	1	2	1	3	3	2	1
CO3	3	2	2	3	2	3	3	2	2	2	2	3	3	3	2
CO4	3	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO5	3	1	2	3	2	3	3	2	3	2	3	3	3	3	3
CO6	3	2	3	3	3	3	3	2	3	2	3	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

REFRIGERATION AND AIR-CONDITIONING (LAB)

General Course Information

Course Code: PCC-ME401-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to describe the components of the Refrigeration and air-conditioning systems.	L1
CO2	Student will be able to compare the performance of refrigeration system at different load conditions	L2
CO3	Student will be able to apply the knowledge of refrigeration and air conditioning principles to conduct experiments.	L3
CO4	Student will be able to analyze and evaluate the performance of refrigeration and air conditioning systems	L4

Lab Contents

1. To study the vapour compression Refrigeration System and determine its C.O.P. and draw P-h and T-S diagrams.
2. To study the Mechanical heat pump and find its C.O.P.
3. To study the Air and Water heat pump and find its C.O.P.
4. To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor.
5. To study the various controls used in Refrigerating & Air Conditioning systems.
6. To study the Ice- plant, its working cycle and determine its C.O.P and capacity.
7. To study the humidification, heating, cooling and dehumidification processes and plot them on Psychrometric charts.
8. To determine the By-pass factor of Heating & Cooling coils and plot them on Psychrometric charts on different inlet conditions.
9. To determine sensible heat factor of Air on re-circulated air-conditioning set up.
10. To study the chilling plant and its working cycle.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/POS Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	--	1	1	--	1	1	--	--	2	--	3	3	2	1
CO2	3	--	1	2	2	1	1	2	1	2	--	3	3	2	1
CO3	3	1	2	3	2	2	2	2	2	2	2	3	3	3	2
CO4	3	2	2	3	3	2	2	2	2	2	2	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MINOR PROJECT

General Course Information

Course Code: PROJ-ME401-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 3.0 Mode: Practical Contact Hours: 6 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to trace out the problem using literature survey/ industry survey to draw an outline for the development or improvement in the existing system of mechanical engineering field.	L1
CO2	Students will be able to summarise various interdisciplinary ideas and technologies which could be used to achieve the desired solution.	L2
CO3	Students will be able to demonstrate an innovative working mechanical system or product which could be the requirement of new generation.	L3
CO4	Students will be able to compare various techniques which could be used to solve the identified problem.	L4
CO5	Students will be able to select the most optimum solution for the identified problem.	L5

Course Contents

Project involving design/ fabrication/ testing computer simulation/ case studies etc. which is commenced in VIIth Semester, will be completed in VIIIth Semester. The student will be required to submit his ideas/objectives in the form of a synopsis to project coordinator and to project guide. Group of 5-6 students choose a project guide and works on the development of any new ideas in the field of Mechanical Engineering

Note:

- ***The design work should also be practiced through latest tools such as ANSYS, solid modeling CAD packages (e.g. AutoCAD, Solidworks, Pro-E, CATIA etc.)***

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	2	3	3	3	3	3	3	3
CO2	3	3	3	2	2	2	1	2	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	1	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

INDUSTRIAL TRAINING PRESENTATION-II

General Course Information

Course Code: PROJ-ME402-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal:100)** Internal continuous assessment of 100 marks on the basis of report writing, presentation and viva voce in practical classes by the team of panel of faculty members.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to get the exposure of 'real' working environment and get acquainted with the organization structure, business operations and administrative functions.	L1
CO2	Students will be able to demonstrate competency in relevant engineering fields through problem identification, formulation and solution.	L2
CO3	Students will be able to develop the ability to work as an individual and in group with the capacity to be a leader as well as an effective team member.	L3
CO4	Students will be able to generate a report based on the experiences with the ability to apply knowledge of Engineering fundamentals	L4
CO5	Students will be master in his profession and perform ethical responsibilities of an engineer	L5

Course Contents

As a part of the B. Tech. Mechanical Engineering Curriculum Industrial Training-II is a Practical course, which the students of Mechanical Engineering should undergo in reputed Private / Public Sector / Government organization / companies as industrial training of four-six weeks in the summer vacation after the VIth semester.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	--	--	--	2	2	--	--	--	2	3	3	3	3
CO2	3	3	3	3	3	--	--	--	--	2	--	2	2	2	2
CO3	--	--	--	--	--	--	--	2	3	--	--	--	--	--	2
CO4	3	--	--	--	--	--	--	--	--	3	--	2	--	--	2
CO5	--	--	--	--	--	1	--	3	--	2	2	2	2	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

GENERAL PROFICIENCY

General Course Information

Course Code: MC-ME401-P Course Category: Mandatory Course Course Credits: 0.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods(internal: 100):** This is a **non-credit course of qualifying nature**. Internal practical evaluation is to be done by the course coordinator.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to state the importance of extra-curricular activities along with academics.	L1
CO2	Students will be able to discuss the role of social activities in career/professional development of an individual.	L2
CO3	Students will be able to choose most feasible solution to tackle the problem in a team.	L3
CO4	Students will be able to criticize the on-going topic in a group discussion.	L4
CO5	Students will be able to argue for the most preferred solution for a project work.	L5

Course Contents

At the end of semester students will be evaluated on the basis of their performance in various fields. The evaluation will be made by the course coordinator. A specimen performa indicating the weightage to each component/ activity is given below :-

Name : _____
Roll No. _____
Branch _____
Year of Admission _____

I. Academic Performance (15 Marks) :

(a) Performance in University Examination :-

Sem.	Result (%age of marks obtained)	Number of Attempt in which the Semester exam has been cleared
I		
II		
III		
IV		
V		
VI		
VII		

II. Extra Curricular Activities (10 Marks) :

Item	Level of Participation	(Position Obtained)	Remarks
Indoor Games (Specify the Games	_____ _____ _____	_____ _____	
Outdoor Games (Specify the Games)	_____ _____ _____	_____ _____ _____	

Essay Competition _____
_____
_____

Scientific Technical Exhibitions _____
_____
_____

Debate _____
_____
_____
_____

Drama _____
_____
_____
_____

Dance _____
_____
_____
_____

Music _____
_____
_____
_____

Fine Arts _____
_____
_____
_____

Painting _____
_____
_____
_____

Hobby Club _____
_____
_____
_____

N.S.S. _____
_____
_____
_____

Hostel Management Activities _____
_____
_____
_____

Any other activity (Please Specify) _____
_____
_____
_____

III. Educational tours/visits/Membership of Professional Societies (5 Marks)

1. _____
2. _____
3. _____
4. _____

IV. Contribution in NSS Social Welfare Floor Relief/draught relief/Adult Literacy mission/Literacy Mission/Blood Donation/Any other Social Service (5 Marks)

1. _____
2. _____
3. _____
4. _____
5. _____

V. Briefly evaluate your academic & other performance & achievements in the Institution (5 Marks)

_____
_____
_____
_____

VI. Performance in Viva voce before the committee (10 Marks)

_____
_____
_____
_____
_____

*Marks obtained 1.( )+II( )+III( )+IV( )+V( )+VI( ) =

**Total Marks :

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	--	--	--	3	2	3	3	3	2	1	1	1	3
CO2	--	--	--	--	--	3	3	3	2	3	1	2	1	1	3
CO3	--	--	--	--	--	1	1	2	3	3	3	3	1	1	3
CO4	--	--	--	--	--	1	1	1	2	3	2	3	1	1	3
CO5	--	--	--	--	--	1	1	1	3	3	3	2	1	1	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -II

Course Code	Course Name	L	T	P	Credits
PEC-ME451-T	Automation in Manufacturing	3	-	-	3.0
PEC-ME452-T	Advanced Welding	3	-	-	3.0
PEC-ME453-T	Tool Engineering	3	-	-	3.0
PEC-ME454-T	Modern Manufacturing Processes	3	-	-	3.0

AUTOMATION IN MANUFACTURING (THEORY)

General Course Information

Course Code: PEC-ME451-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to memorize the concepts of automation theory and its applications in various fields of manufacturing.	L1
CO2	Students will be able to describe principles, methods, and hardware/software tools used in Hydraulics/Pneumatics Electro-pneumatic controls and devices.	L2
CO3	Students will be able to illustrate the principles of Rapid Prototyping, classifications of different RP techniques along with their applications.	L3
CO4	Students will be able to develop the concepts of Automatic transfer machines with assembly automation.	L4

Course Contents

UNIT-I

Introduction to Factory Automation and Integration: Basic Concepts, Types of automation, Modern developments in automation in manufacturing and its effect on global competitiveness, Need and implications of automation in Manufacturing.

UNIT-II

Introduction to Hydraulics/Pneumatics Electro-pneumatic controls and devices, Basic elements hydraulics/pneumatics, Electro-pneumatic systems, Fluid power control elements and standard graphical symbols for them, Construction and performance of fluid power generators, Hydraulic & pneumatic cylinders - construction, design and mounting, Hydraulic & pneumatic valves for pressure, Flow & direction control, Servo valves and simple servo systems with mechanical feedback, Solenoid, Different sensors for electro-pneumatic system, hydraulic, pneumatic & electro-pneumatic circuits.

UNIT-III

Introduction to rapid prototyping (RP), Basic Principles of RP, Steps Classifications of Different RP Techniques. Materials for RP: Plastics, Ceramics, Resins, Metals, Selection criterions processes, the advantages and limitations of different types of materials.

UNIT-IV

Automatic transfer machines: Classifications, Analysis of automated transfer lines, without and with buffer storage, Group technology and flexible manufacturing system.

Assembly automation: Types of assembly systems, Assembly line balancing, Performance and economics of assembly system.

Text and Reference Books

1. Groover, M. P., "Automation, Production systems and Computer Integrated Manufacturing", 2nd Ed., Prentice Hall, 2005.
2. Boothroyd, G., "Assembly Automation and Product Design", 2nd Ed., Marcel Dekker, 1992.
3. Boothroyd, G., Dewhurst, P. and Knight, W., "Product Design for Manufacture and Assembly", 2nd Ed., Taylor & Francis, 2002.
4. Boothroyd, G., Poli, C. and Murch, L. E., "Automatic Assembly", Marcel Dekker, 1982.
5. Tergan, V., Andreev, I. and Lieberman, B., "Fundamentals of Industrial Automation", Mir Publishers,

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1
CO2	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1
CO3	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1
CO4	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

ADVANCED WELDING (THEORY)

General Course Information

Course Code: PEC-ME452-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define welding, its mechanism, welding processes and welding defects	L1
CO2	Students will be able to describe principles, methods, welding defects and their maintenance	L2
CO3	Students will be able to examine and compare different welding process	L3
CO4	Students will be able to select the welding process for different materials	L4

Course Contents

UNIT-I

Introduction- Classification of welding processes, physics of welding arc, arc stability, arc blow, polarity, welding symbols, safety and hazards in welding. Metal Transfer: Mechanism and types of metal transfer in various arc welding processes.Welding consumables: Classification and selection of welding electrodes and filler rods, welding fluxes, characteristics and manufacturing of the welding fluxes, characteristics of different shielding gases.

UNIT-II

Welding processes: Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electrogas and Electroslag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwave welding. Weldability: Definition, different tests of weldability, weldabitity of steel, stainless steel, cast iron, aluminum and titanium.

UNIT-III

Joining of ceramics and plastics processes: Allied welding processes: brazing, soldering, metal spraying, and gas & arc cutting of steels, stainless steel and cast iron, thermal spraying, plasma cutting. heat flow welding: calculation of peak temperature; width of heat affected zone; cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

UNIT-IV

Welding defects: Different types of welding defects, causes and remedies, testing for identifying defects. Welding distortion and residual stresses**:** Types, factors affecting the distortion and residual stresses, methods of reducing the distortion. Repair & Maintenance Welding: Hard facing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Text and Reference Books

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principals and Practices, by- Edwars R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, Khanna Publishsers.
4. Jean Cornu, Advanced welding systems, IFS.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	--	--	--	--	--	--	2	--	3	2	2	2
CO2	3	1	1	1	--	--	--	--	--	2	--	3	2	2	2
CO3	3	1	2	1	--	--	--	2	--	2	--	3	2	2	2
CO4	3	2	2	1	--	--	--	2	--	2	--	3	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

TOOL ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME453-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the different manufacturing devices viz. various cutting and gaging tools and their materials, work holding devices, jigs and fixtures, and dies.	L1
CO2	Students will be able to describe different manufacturing devices along with their principles.	L2
CO3	Students will be able to solve different kind of problems related to selection of manufacturing devices.	L3
CO4	Students will be able to compare different manufacturing devices effectively.	L4
CO5	Students will be able to select and design appropriate manufacturing device required to manufacture a particular component.	L5

Course Contents

UNIT-I

Cutting Tool Materials: Desirable Properties of Cutting Tool Materials, Different Types of Cutting Tool Materials, Cutting-Tool Reconditioning

Design of Cutting Tools: Basic Mechanics and Geometry of Chip Formation, General Considerations for Metal Cutting, Design of Single Point Cutting Tools, Design of Milling Cutters, Design of Drills

.

UNIT-II

Gages: Definition of gage, Types of Gages, Gage Tolerances, Material for Gages

Work Holding Devices: Location: Principles, Methods and Devices, Clamping: Principles, Methods and Devices

UNIT-III

Drill Jigs: Definition and Types of Drill Jigs, General Considerations in the Design of Drill Jigs, Drill Bushings

Fixtures: Fixtures and Economics, Types of Fixtures

UNIT-IV

Bending, Forming and Drawing Dies: Bending Dies, Forming Dies, Drawing Operations, Variables that Affect Metal Flow during Drawing

Tool Design for Numerically Controlled Machine Tools: Fixture Design for Numerically Controlled Machine Tools, Cutting Tools for Numerical Control, Tool-Holding Methods for Numerical Control.

Text and Reference Books

1. Mehta, N. K., "Metal Cutting and Design of Cutting Tools, Jigs & Fixtures" , McGraw Hill Education (India) Private Limited
2. Cyril Donaldson, George H LeCain, Goold V.C., JoyjeetGhose , "Tool Design", Tata-McGraw Hill.
3. Jeff Lantrip, John G. Nee, David Alkire Smith, "Fundamentals of Tool Design", Society of Manufacturing Engineers
4. Jones E.J.H., Town H.C., "Production Engineering: Jig and Tool Design", Butterworth and Co (Publishers) Ltd

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MODERN MACHINING PROCESSES (THEORY)

General Course Information

Course Code: PEC-ME454-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the basic principles, construction and working of modern machining methods.	L1
CO2	Students will be able to explain the applications, advantages, and limitations of new machining methods.	L2
CO3	Students will be able to differentiate various non-traditional machining processes.	L3
CO4	Students will be able to select the correct non-conventional material removal process	L4

Course Contents

UNIT-I

Unconventional Machining Process: Characteristics of Modern Machining Processes, Basic Principles of New Machining Methods, Advantages and Limitations of Non-traditional Machining Processes.

Electric Discharge Machining (EDM): Operating Principles of Spark Erosion, Construction details and components of Spark Erosion Machines (Schematic Diagrams), Applications, Advantages, and Limitations of EDM process.

UNIT-II

Electro-Chemical Machining (ECM): Principle of ECM process, ECM process Details with Chemical Reactions (Schematic Diagram), Advantages, Disadvantages and Application of ECM process.

Electron Beam Machining (EBM): Description of EBM process (Schematic Diagrams), Applications and Limitations of Electron Beam Machining, Electron Beam Welding (EBW), and Laser beam Welding (LBW).

UNIT-III

Ultrasonic Machining (USM): Basic Principle of the USM, Essential components of USM, Performance Parameters of USM, Applications, Advantages and Limitations of USM.

Abrasive Jet Machining (AJM): Features of AJM (Schematic Diagrams), Practical Applications of AJM, Advantages and Disadvantages of AJM, Water Jet Machining (WJM).

UNIT-IV

Chemical Machining (CHM): Basic Techniques of CHM, Mechanism of CHM, Process Variables in CHM, Advantages and Applications of CHM.

Comparison of Unconventional Machining Processes: Comparison on Power Consumption basis, Selection of Non-traditional Machining process, Effect of Non-conventional Material removal processes on Surface Integrity.

Text and Reference Books

1. Unconventional Machining Process – M.Adithan, Atlantic
2. Modern Machining Processes – P.C.Pandey, H.S.Shan, Tata McGraw Hill
3. Machining Science- Ghosh and Malik, Affiliated East-West Press
4. Non Traditional Manufacturing Processes- Benedict G.F, Marcel Dekker
5. Advanced Methods of Machining- Mc Geongh J.A, Chapman and Hall

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	--	--	--	--	--	--	2	--	2	2	2	1
CO2	3	1	--	--	--	--	--	--	--	2	--	2	2	2	1
CO3	3	--	2	--	--	2	--	--	2	2	1	3	3	2	2
CO4	3	--	2	--	--	2	2	3	2	2	2	3	3	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -III

Course Code	Course Name	L	T	P	Credits
PEC-ME455-T	Introduction to Tribology	3	-	-	3.0
PEC-ME456-T	CNC Technology	3	-	-	3.0
PEC-ME457-T	Reverse Engineering	3	-	-	3.0
PEC-ME458-T	Product Design and Development	3	-	-	3.0

INTRODUCTION TO TRIBOLOGY (THEORY)

General Course Information

Course Code: PEC-ME455-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the interdisciplinary subject 'Tribology' and its technological significance	L1
CO2	Students will be able to examine the genesis of friction and wear	L2
CO3	Students will be able to learn about the principles of lubrication, lubrication regimes, hydrodynamic lubrication and hydrostatic lubrication.	L3
CO4	Students will be able to analyze real life problem in tribology.	L4

Course Contents

UNIT-I

Introduction: History of Tribology, Introduction to Friction, Wear and Lubrication, Characteristic features of tribological systems, Surface topography, environmental and Economic aspects of tribology.

UNIT-II

Friction: Causes of friction, Adhesion theory, Abrasive theory, Junction growth theory, Laws of rolling friction, Modeling of friction. Wear: Wear mechanisms, Adhesive wear, Abrasive wear, Corrosive war, Fretting wear, Modeling of wear.

UNIT-III

Physical Properties of Lubricants: Introduction, Oil viscosity, Viscosity temperature relationship, Viscosity index, Viscosity pressure relationship, Viscosity-shear rate relationship, Viscosity measurements, Viscosity of mixtures, Oil viscosity classification, Lubricant density and specific gravity, Thermal properties of lubricants, Temperature characteristics of lubricants, Other lubricants characteristics, Optical properties of lubricants, Additive compatibility and solubility, Lubricant impurities and contaminants, Solubility of gases in oils.

Lubricants and Their Composition: Introduction, Mineral oils, Synthetic oils, Emulsions and aqueous lubricants, Greases, Lubricant additives.

UNIT-IV

Fluid Film Lubrication: Regimes of fluid film lubrication, Hydrodynamic Lubrication; Introduction, Generalized Reynolds equation, Converging-diverging wedges, Journal bearings, Thermal effects in bearings, Limits of hydrodynamic lubrication, Hydrodynamic lubrication with non-Newtonian fluids, Reynolds equation for squeeze films, Porous bearings.Hydrostatic Lubrication; Basic concepts, Aerostatic bearings, Hybrid bearings, Stability of journal bearings.

Text and Reference Books

1. Conner, J.J. and Boyd, J., "Standard Handbook of Lubrication Engineering", McGraw Hill (1968)
2. Khonsari, M. M. and Booser, E. R., "Applied Tribology: Bearing Design and Lubrication", 2nd Ed, Wiley (2008)
3. Kudish, I. I. and Covitch, M. J., "Modeling and Analytical Methods inTribology", Chapman and Hall/CRC (2010)
4. Bhushan, B., "Principles and Applications of Tribology", 2nd Ed., Wiley (2013)
5. Stachowiak, G.W. and Batchelor, A. W., "Engineering Tribology", 4th Ed,Butterworth-Heinemann (2013)
6. Wyong B., "Tribology: Engineering Applications", NY Research Press (2015)
7. Hirani H., "Fundamentals of Engineering Tribology with Applications", Cambridge University Press(2016)

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	--	--	--	--	3	2	--	--	--	--	2	3	2	3
CO2	3	2	3	2	--	2	--	--	--	--	--	2	3	1	3
CO3	3	2	3	2	3	--	--	--	--	--	--	3	3	2	3
CO4	3	2	3	3	3	--	--	--	--	--	2	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

CNC TECHNOLOGY (THEORY)

General Course Information

Course Code: PEC-ME456-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe construction, working and tooling systems in Computer Numeric Control (CNC) machines.	L1
CO2	Students will be able to demonstrate the working of CNC machines through the Manual part programming and Automatically Programmed Tool (APT) language.	L2
CO3	Students will be able to distinguish between the different features of CNC Turning Center and CNC Machining Center.	L3
CO4	Students will be able to select the different CNC process as per the machining process.	L4
CO5	Students will be able to develop CNC programs as per the ISO standards, process, machine and tooling arrangements.	L5

Course Contents

UNIT-I

Computer Numerical Control (CNC) Technology: Numerical Control (NC), Historical Development of CNC Machines, NC Coordinate Systems, NC Modes, Advantages and Limitations of CNC Machine Tools.
CNC Hardware: Structure of CNC Machine tools, Drives used in CNC machines, Actuation Systems of CNC Machines Tools, Feedback Devices used in CNC Machine.

UNIT-II

CNC Programming Fundamentals: Part Programming Steps, Axes Identification in CNC Turning and Machining Centres, Machine Zero and Home Position, ISO Standards for Coding.
Manual Part Programming: Preparatory Functions, Miscellaneous Functions, Absolute and Incremental Programming, Tool Length Compensation.

UNIT-III

Turning Centre Programming: Motion Commands, Tool Nose Radius Compensation, Cut Planning, Thread Cutting, Part Program Numericals.

Machining Centre Programming: Canned Cycles, Cutter Radius Compensation, Part Program Numericals.

UNIT-IV

Computer Aided Part Programming : APT Language, Geometry Statements, Motion Statements, Post Processor Statements, Auxiliary Statements, Part Program Numericals.

CNC Tooling: Cutting Tool Material and Characteristics, Turning Tool Geometry, Tooling System for Turning, and Milling. Tool Presetting, Automatic Tool Changers, Work Holding.

Text and Reference Books

1. Jon S. Stenerson, Kelly Curran, "Computer Numerical Control: Operation and Programming", Prentice Hall, 3rd edition 2007.
2. Mattson Mike, "CNC Programming: Principles & Applications", Cengage learning, 1st edition 2013.
3. Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Higher Education, 3rd edition 2013.
4. Michael J. Peterson, "CNC Programming: Basics & Tutorial Textbook", Create Space Independent Publishing Platform, 1st edition 2008.
5. Peter Smid, "CNC Tips and Techniques: A Reader for Programmers", Industrial Press Inc., 1st edition 2013.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	--	1	1	2	1	1	3	3	3	1
CO2	3	3	1	1	1	--	1	1	2	2	1	3	3	3	1
CO3	3	3	1	1	1	--	1	1	2	1	1	3	3	3	1
CO4	3	3	1	1	1	--	1	1	2	2	1	3	3	3	1
CO5	3	3	1	1	1	--	1	1	2	3	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

REVERSE ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME457-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe phases of reverse engineering for geometric model development.	L1
CO2	Students will be able to understand methodologies and techniques used for reverse engineering.	L2
CO3	Students will be able to select a reverse engineering system	L3
CO4	Students will be able to discuss case studies for understanding relationship between reverse engineering and rapid prototyping.	L4

Course Contents

UNIT-I

Introduction: Reverse engineering fundamentals-The generic process-Three phases of reverse engineering-Phase I: Scanning, Phase II: Point processing, Phase III: Geometric model development.

UNIT-II

Methodologies and techniques of Reverse Engineering: Computer aided reverse engineering, Computer vision and reverse engineering, Structured light range imaging, Scanner pipeline.

UNIT-III

Reverse engineering hardware and software: Introduction, Reverse engineering hardware, Reverse engineering software, Selection of a reverse engineering system, Case studies with implementation.

UNIT-IV

Introduction to rapid prototyping: Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Digital prototyping, Virtual prototyping, Applications, Relationship between reverse engineering and rapid prototyping, Case studies with implementation.

Text and Reference Books

1. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, 1st edition, Prentice Hall, 2001. ISBN-13: 978-0130212719.
2. V. Raja and K. Fernandes, Reverse Engineering: An Industrial Perspective, Springer- Verlag, 2008. ISBN: 978-1-84628-855-5.
3. K. A. Ingle, Reverse Engineering, McGraw-Hill, 1994. ISBN-13: 978-0070316935.
4. L. Wills and P. Newcomb, Reverse Engineering, 1st edition, Springer-Verlag, 1996. ISBN-13: 978-1475788280.
5. C. K. Chua, K. F. Leong and C. S. Lim, Rapid Prototyping: Principles and Applications, 4th edition, World Scientific, 2010. ISBN: 978-981-277-897-0.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	--	--	--	--	--	--	--	--	2	--	3	2	1	1
CO2	2	--	1	2	2	--	--	--	--	2	--	3	3	2	2
CO3	2	--	2	3	3	--	2	--	2	2	--	3	3	2	2
CO4	2	3	2	3	3	--	2	--	2	2	--	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

PRODUCT DESIGN AND DEVELOPMENT (THEORY)

General Course Information

Course Code: PEC-ME458-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks.For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe design process, design models, design phases, design strategies, design planning and design specifications.	L1
CO2	Students will be able to understand the concept of design for 'X', particularly design for manufacturing processes, design for aesthetics, design for ergonomics, design for assembly, design for economics and design for environment.	L2
CO3	Students will be able to demonstrate industrial design concepts.	L3
CO4	Students will be able to make use of different tools for product design.	L4

Course Contents

UNIT-I

Product Design Philosophy: Design process, design models, design phases, product design strategies, product design planning and specification, need analysis, concept generation, concept selection, concept testing, Modern product development process, Innovative thinking, Morphology of design.

UNIT-II

Design considerations: General considerations in design for casting, forging, machining, powder metallurgy and welding, Design considerations for assembly.

Material selection processing and Design: Material Selection Process, Economics, Cost Vs Performance, Weighted property Index, Value Analysis

UNIT-III

Design for aesthetics and ergonomics: Human Factors in Design, Aesthetics considerations in design-Basic types of product forms, designing for appearance, shape, features, materials and finishes, Ergonomic considerations in design display and controls, workspace design, hand tool design, human engineering considerations-Relation between man, machine and environmental factors.

Societal consideration – Contracts, Product liability, Protecting intellectual property, Legal and ethical domains, Codes of ethics, Ethical conflicts, Environment responsible design-future trends in interaction of engineering with society.

UNIT-IV

Industrial Design concepts: human factors design, user friendly design, design for serviceability, design for environment, prototyping and testing , cost evaluation, categories of cost, overhead costs, activity based costing, methods of developing cost estimates, manufacturing cost, value analysis in costing.

Tools for product design: Concurrent Engineering, Rapid prototyping, Drafting/Modeling software CAM, Interface Reverse Engineering.

Text and Reference Books

1. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill.
2. Product Development, by Chitale & Gupta, Tata McGraw Hill
3. The Mechanical Process Design, by David Ullman, McGrawhill Inc
4. Engineering Design Process, by Yousef Haik, T M MShahin, Cengage Learning
5. Product design & process Engineering by Niebel & deeper, McGraw hill
6. Value Management by Heller, Addison Wasley
7. Value Engineering A how to Manual S.S.Iyer, New age International Publishers
8. Value Engineering : A Systematic Approach by Arthur E. Mudge - Mc GrawHill
9. New Product Development Timjones. Butterworth Heinmann, Oxford.
10. Value Engineering A how to Manual S. S. Iyer, New age International Publishers
11. Value Engineering : A Systematic Approach by Arthur E. Mudge - Mc GrawHill
12. Assembly automation and product design – by Geoffrey Boothroyd, CRC Taylor & Francis

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	--	2	--	--	--	--	--	--	3	2	2	2
CO2	3	2	3	--	2	--	--	--	--	--	--	3	2	2	2
CO3	3	2	3	--	2	--	--	--	--	--	--	3	2	2	2
CO4	3	2	3	--	3	--	--	--	--	--	--	3	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

8th Semester

MECHANICAL VIBRATIONS (THEORY)

General Course Information

Course Code: PEC-ME402-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the fundamentals, principle and cause of mechanical vibrations.	L1
CO2	Student will be able to understand the various methods of solving vibration problems and apply them to vibration problems.	L2
CO3	Student will be able to analyse and solve single, two and multi degree of freedom practical vibration problems.	L3
CO4	Student will be able to analyse and solve free and forced mechanical vibration problems.	L4
CO5	Student will be able to understand and apply Numerical Methods to solve multi DOF vibration problems.	L5

Course Contents

UNIT-I

Free and Damped Vibrations : Importance of Study of Vibrations, Classifications of Vibrations, Free and Forced, Undamped and Damped, Linear and Non-linear, Deterministic and Random, Harmonic Motion, Vector and Complex Number Representations, Definitions and Terminology, Periodic Functions, Harmonic Analysis, Fourier Series Expansion. Single Degree of Freedom system, D'Alemberts Principle, Energy Methods, Rayleighs Method, Application of these Methods, Damped Free Vibrations, Logarithmic Decrement, Under Damping, Critical and Over Damping, Coulomb Damping.

UNIT-II

Harmonically Excited Vibrations : Forced Damped Harmonic Vibration of Single Degree of Freedom Systems, Rotating Unbalance, Rotor Unbalance, Critical Speeds and Whirling of Rotating Shafts, SupportMotion, Vibration Isolation, Energy Dissipated by Damping, Equivalent, Viscous Camping, Structural Damping Sharpness of Resonance, Vibration Measuring Instruments.

UNIT-III

Two Degrees of Freedom Systems: Introduction to Multi-Degree of Freedom Systems, Normal Mode Vibrations, Coordinate Coupling, Principal Coordinates, Free Vibrations in Terms of Initial Conditions, Forced Harmonic Vibrations, Vibration Absorber, Centrifugal Vibration Absorber, Vibration Damper. Normal Mode Vibration of

Continuous System**:** Vibrating String, Longitudinal Vibrations of Rod, Torsional Vibrations of Rod, and Lateral Vibrations of Beam.

UNIT-IV

Multi degrees of Freedom Systems and Numerical Methods: Introduction, Influence Coefficients, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes, Orthogonality of Normal Modes, Dunkerley's Equation, Method of Matrix Iteration, The Holzer Type Problem, Geared and Branched Systems, Beams.

Text and Reference Books

1. Mechanical vibrations: J.S. Mehta & A.S. Kailey, S.Chand.
2. Mechanical vibrations: V.P. Singh, Dhanpat Rai & Co.
3. Theory of Vibrations with Applications W.T. Thomson, Prentice Hall of India.
4. Mechanical Vibration: G.K. Grover and S.P. Nigam, Nem Chand and Sons.
5. Theory and Practice of Mechanical Vibrations J.S. Rao and K. Gupta, Wiley Eastern Ltd.
6. Mechanical Vibrations S.S. Rao, Addison – Wesely Publishing Company

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	1	1	1	1	1	1	1	3	3	2
CO2	3	3	1	2	1	1	1	1	1	1	1	1	3	3	2
CO3	3	3	3	2	1	1	1	1	1	1	1	1	3	3	2
CO4	3	3	1	2	1	1	1	1	1	1	1	1	3	3	2
CO5	3	3	1	2	1	1	1	1	1	1	1	1	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

COMPUTER AIDED DESIGN AND MANUFACTURING (THEORY)

General Course Information

Course Code: PEC-ME403-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to define the scope and applications of CAD/CAM and geometric modeling techniques.	L1
CO2	Student will be able to understand the basic overview of geometric transformations, curves, surface and solids.	L2
CO3	Student will be able to use computer assisted part programming for CNC machines	L3
CO4	Student will be able to generate CNC part programmes	L4

Course Contents

UNIT-I

Introduction to CAD/CAM: Historical developments, product life cycle, CAD/CAM systems, scope of CAD/CAM, CAD/CAM applications, 3D modeling approaches, types of geometric modeling, coordinate systems, sketching and sketch planes, basic features of a CAD/CAM system (extrusion, revolution, hole, cut, sweep, loft, fillet, chamfer, rib, shell, draft, patterns spiral and helix), feature based modeling, parametric modeling, datum features, geometric constraints, modeling operations, heterogeneous modeling, modeling strategies, master model, system modes, model viewing .

UNIT-II

Transformations: Introduction, transformation of points and line, 2-D translation, rotation, reflection, scaling, homogeneous representation, concatenated transformation, mapping of geometric models, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, orthographic, Isometric and perspective projections.

Curves: Algebraic and geometric forms, tangents and normal, blending functions re-parameterization, straight lines, conics, cubic Splines, Bezier curves and B-Spline curves.

UNIT-III

Surfaces: Algebraic and geometric forms, tangents and normal, blending functions, re-parameterization, sixteen point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-Spline surface, surface manipulations.

Solids: Geometry and topology, Solid models and representation schemes, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, solid manipulators.

UNIT-IV

CNC Technology: Introduction, types of NC systems, NC machine tools, principle of operation of CNC, advantages and limitations of CNC systems, Direct numerical control (DNC) and its application, MCU and other components.

Part Programming: Integrating CAD, NC and CAM, preparing CAD data for NC system, NC part programming, coordinate systems, NC programming languages, G & M codes, Part program for simple parts, CNC part programming, axes of CNC machines, computer aided part programming using APT, Automatic NC program generation from CAD models.

Text and Reference Books

1. Zeid, I., "CAD/CAM", McGraw Hill, 2008.
2. Groover and Zimmer, "CAD/ CAM", Prantice Hall.
3. Rogers, D. F. and Adams, J. A., "Mathematical Elements for Computer Graphics", McGraw Hill.
4. Radhakrishnan, P. and Kothandaraman, C. P., "Computer Graphics & Design", Dhanpat Rai Publication", 2nd edition, 2005.
5. Krishnamoorathy, C. S. and Rajeev, J. S., "Computer Aided Design (Software and Analysis Tools)", Narosa Publication House, 2nd edition, 2005.
6. Kundra T. K., Rao P. N. and Tiwari N. K, "Numerical Control and Computer Aided Manufacturing", McGraw Hill.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	1	1	1	--	--	--	2	--	3	3	2	2
CO2	3	2	2	2	2	1	--	--	--	2	--	3	3	3	2
CO3	3	2	2	3	2	1	--	--	2	2	--	3	3	3	2
CO4	3	2	2	3	3	2	--	--	2	2	--	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

COMPUTER AIDED DESIGN AND MANUFACTURING (LAB)

General Course Information

Course Code: PCC-ME403-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to draw part drawings and three-dimensional models using CAD techniques.	L1
CO2	Students will be able to generate part programs for industrial components using CAM techniques	L2
CO3	Students will be able to demonstrate working of CNC machines	L3
CO4	Students will be able to examine the industrial drawings and manufactured parts.	L4
CO5	Students will be able to create a product from conceptualization to reality.	L5

Lab Contents

1. To prepare part drawing on CAD softwares (Auotcad, Draftsight etc.)
2. To perform parametric modelling on CAD softwares (Creo/Solid Works/Catia/Inventor etc.).
3. To understand CNC codes and their syntax in respect of CNC Turning Center, CNC Machining Center, and CNC Wire Cut EDM.
4. To perform component identification and work setting of CNC Turning Center.
5. To perform component identification and work setting of CNC Machining Center.
6. To perform component identification and work setting of CNC Wire Cut EDM.
7. To prepare part program for CNC Turning center using CAM software (Cam Concept, Fusion 360, Master Cam etc.)
8. To prepare part program for CNC Machining center using CAM software (Cam Concept, Fusion 360, Master Cam etc.)
9. To prepare part program for CNC Wire Cut EDM using CAM software (Elcam etc.)
10. To machine an industrial part using CNC Turning Center.
11. To machine an industrial part using CNC Machining Center.
12. To machine an industrial part using CNC Wire Cut EDM.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO2	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO3	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO4	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO5	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MAJOR PROJECT

General Course Information

Course Code: PROJ-ME403-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 5.0 Mode: Practical Contact Hours: 10 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to relate the theoretical studies that they learned in the preceding semesters with practical concepts.	L1
CO2	Students will be able to recognise their skill for the solution of identified problem and to develop a prototype mechanical system.	L2
CO3	Students will be able to apply the analytical and design procedures to synthesize a working prototype of a functional mechanical system.	L3
CO4	Students will be able to examine the conditions faced by an engineer starting from the development / modification of an existing functional mechanical system.	L4
CO5	Students will be able to appraise the necessity of project management, teamwork, time management, system integration skills and other related human factors involved in the design and development cycle of an engineering system.	L5

Course Content

Project involving design/ fabrication/ testing computer simulation/ case studies etc. which is commenced in VIIth Semester, will be completed in VIIIth Semester. The student will be required to demonstrate his ideas/design/development in front of the committee constitute of a project coordinator, project guide and senior teachers of the department.
The student will be required to submit three copies of his/her project report to the office of the concerned department for record (one copy each for the deptt. Office, Project guide and University/College library).

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	2	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	1	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	1	2	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	1	2	3	3	3	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

SEMINAR

General Course Information

Course Code: PROJ-ME404-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn recent trends and technologies in the field of Mechanical Engineering	L1
CO2	Students will be able to recognizing problems after doing research literature survey using various resources	L2
CO3	Students will be able to prepare concise, comprehend and conclude selective topic in the field of Mechanical Engineering	L3
CO4	Students will be able to develop skills in presentation and discussion of research topics in a public forum	L4

Course Content

The students are required to give power point presentation on the topic related to current research area in the field of Mechanical Engineering. The students are also required to submit a detailed report on the topic of seminar. The presentation should be held in the class room/ seminar hall in presence of the course coordinator.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	--	--	--	--	--	2	2	3	--	2
CO2	3	1	2	2	--	--	--	--	--	2	--	2	2	--	2
CO3	--	--	--	--	--	--	--	--	--	3	--	2	--	--	--
CO4	3	2	2	2	--	--	--	--	--	3		2	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -IV

Course Code	Course Name	L	T	P	Credits
PEC-ME459-T	Robotics	3	-	-	3.0
PEC-ME460-T	Mechatronics	3	-	-	3.0
PEC-ME461-T	Automatic Control	3	-	-	3.0
PEC-ME462-T	Flexible Manufacturing Systems	3	-	-	3.0
PEC-ME463-T	Rapid Prototyping	3	-	-	3.0

ROBOTICS (THEORY)

General Course Information

Course Code: PEC-ME459-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks.For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn standard terminologies, applications, design specifications, and mechanical design aspects both kinematics, Trajectory planning, work cell control and dynamics of industrial robotic manipulators.	L1
CO2	Students will be able to understand the robot kinematics and trajectory planning	L2
CO3	Students will be able to apply the concepts of robotic workspace analysis for design of robotic manipulator for required work cell applications	L3
CO4	Students will be able to develop the algorithms for design of robotic work cell controller and its programming for given serial robotic manipulator	L4

Course Content

UNIT-I

Robotic Manipulation: Automation and Robots; Robot Classification – Drive Technologies, Work-Envelope Geometries, Motion Control Methods, Applications; Robot Specifications – No. of Axes, Capacity and Speed, Reach and Stroke, Tool Orientation, Repeatability, Precision, Accuracy, Operating Environment, An Example; Rhino X-3.

Direct Kinematics: The Arm Equation Homogenous Co-ordinates – Frames, Translations and Rotations, Composite Homogenous Transformations; Screw Transformations; Link Co-ordinates; The Arm Equation; A Five-Axis Articulated Robot; A Four-Axis SCARA Robot; A Six-Axis Articulated Robot; Problems.

UNIT-II

Inverse Kinematics: Solving the Arm Equation: The Inverse Kinematics Problem; General Properties of Solutions; Tool Configuration; Inverse Kinematics of a Five-Axis Articulated Robot, Four-Axis SCARA Robot, Six-Axis Articulated Robot and Three-Axis Planer Articulated Robot; A Robotic Work Cell; Problems.

Work Space Analysis and Trajectory Planning: Work Space Analysis; Work Envelope of a Five-Axis Articulated Robot; Work Envelope of a Four Axis SCARA Robot; Work Space Fixtures; The Pick and Place Operation; Continuous Path Motion; Interpolated Motion; Straight Line Motion; Problems.

UNIT-III

Differential Motion and Statics: The Tool Configuration Jacobian Matrix; Joint – Space Singularities; Generalised Inverses; Resolved – Motion Rate Control; n > 6; Rate Control of Redundant Reboots : n > 6; Rate Control using (1) – Inverses; The Manipulator Jacobian; Induced Joint Torques and Forces; Problems.

Manipulator Dynamics: Lagrange's Equation; Kinetic & Potential Energy; Generalised Force; Lagrange – Euler Dynamic Model; Dynamic Models of a Two-Axis Planer Articulated Robot and A Three-Axis SCARA Robot; Direct & Inverse Dynamics; Recursive Newton - Euler Formulation; Dynamic Model of a One-Axis Robot; Problems.

UNIT-IV

Robot Control: The Control Problems; State Equations; Constant Solutions; Linear Feedback Systems; Single-Axis PID Control; PD-Gravity Control; Computed –Torque Control; Variable-structure Control; Impedance Control; Problems.

Methods of Robot Programming: Robot programming methods, introduction to basic robot programming languages, and various on-line and off-line robot programming methods.

Text and Reference Books

1. Fundamental of Robotics (Analysis &Control) by Robert J. Schilling, Published by PHI, Pvt. Ltd., New Delhi.
2. Introduction to Robotics (Mechanics & Control) by John J. Craig, Published by Addition Wesley (Intl. Student Edition).
3. Analysical Robotics & Mechatronics by Wolfram Stadler, Published by Mc-Graw Hill, Inc., New Delhi.
4. Industrial Robotics - Technology, Programming &Applications byMikell P. Grover, Weiss, Nagel and Ordef, Published by Mc-Graw Hill International Edition.
5. A Robot Engg. Test Book - Mohsen Shahinpoor, Harper & Low, Publishing New York.
6. Robotic Engineering – An Integrated Approach: Richard D.Klafter, Thomas A. Chmielewski and Michael Negin PHI 1989.
7. Foundations of Robotics Analysis and Control - Tsuneo Yashikawa MIT Press 1990, Indian Reprint 1998.
8. Robots and Control - R.K.Mittal and I.J.Nagrath - Tata McGraw Hill 2003.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	--	--	--	--	--	2	--	2	3	2	2
CO2	3	1	2	2	2	--	--	--	--	2	--	2	2	2	2
CO3	2	2	2	2	3	--	--	2	--	3	--	2	3	2	2
CO4	3	2	2	2	3	--	--	2	--	3	--	2	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MECHATRONICS (THEORY)

General Course Information

Course Code: PEC-ME460-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to construct the block diagram of any physical Mechatronics device used in day-to-day life	L1
CO2	Students will be able to calculate the output to input relation of any physical model in the form of a transfer function	L2
CO3	Students will be able to evaluate the performance of any physical system in terms of its performance parameters.	L3
CO4	Students will be able to develop the mathematical model of any physical model from any engineering domain	L4
CO5	Students will be able to recognize the key features of different type of controllers and develop a suitable controller to obtain the desired performance from the system.	L5

Course Content

UNIT-I

Introduction and Basics: Mechatronics, Measurement System with its constituent elements; Open and Closed Loop Systems; Sequential Controllers; Micro-processor Based Controllers; The Mechatronics Approach.

Hardware of Measurement Systems: A review of Displacement, Position Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors / alongwith Performance Terminology; Selection of Sensors; Input Data by Switches; Signal Conditioning; Brief Review of Operational Amplifier; Protection; Fitering; Wheat Stone Bridge; Digital Signals; Multiplexers; Data Acqusition; Digital Signal Processing; Pulse Modulation; Data Presentation Systems – Displays; Data Presentation Elements; Magnetic Recording; Data Acquisition Systems; Testing & Calibration; Problems.

UNIT-II

Pneumatic, Hydraulic, Mechanical and Electrical Actuation Systems: Pneumatic and Hydraulic Systems; Directional Control Valves; Valve Symbols; Pressure Control Valves; Cylinder Sequencing; Process Control Valves; Rotary Actuators; Mechanical Systems – Types of Motion, Kinematic Chains, Cams, Gear Trains, Ratchet & Pawl, Belt & Chain Drives, Bearings, Mechanical Aspect of Motor Selection; Electrical Systems; Mechanical & Solid State Switches; Solenoids; D.C. & A.C. Motors; Stepper Motors; Problems.

System Modeling and Performance: Engg. Systems; Rotational – Translational Systems; Electro-mechanical Systems; Hydraulic – Mechanical Systems; A review of modeling of First and Second Order Systems and

Performance Measures; Transfer Functions for first order System, Second Order System, Systems in series & Systems with Feedback Loops; Frequency Response of First Order and Second Order Systems; Bode Plots: Performance Specifications: Stability; Problems.

UNIT-III

Closed Loop Controllers: Continuous and Discrete Processes – Lag, Steady State Error; Control Modes; Two- step Mode; Proportional Mode – Electronic Proportional Controllers; Derivative Control – Proportional plus Derivative Control; Integral Control - Proportional plus Integral Control; PID Controller – Operational Amplifier PID Circuits; Digital Controllers – Implementing Control Modes; Control System Performance; Controller Tuning – Process Reaction Method & Ultimate Cycle Method; Velocity Control; Adaptative Control; Problems.

Digital Logic and Programmable Logic Controllers: A Review of Number Systems & Logic Gates; Boolean Algebra; Kanaugh Maps; Sequential Logic; Basic Structure of Programmable Logic Controllers; Input/ Output Processing; Programming; Timers, Internal Relays and Counters; Master & Jump Controls; Data Handling; Analogue Input/ Output; Selection of a PLC; Problems.

UNIT-IV

Microprocessors and Input/Output Systems: Control; Microcomputer Structure; Micro- controllers; Applications; Programming Languages; Instruction Sets; Assembly Language Programs; Subroutines; Why C Language ? A review of Program Structure, Branches, Loops, Arrays, Pointer; Examples of Programs; Interfacing; Input/ Output; Interface Requirements; Peripheral Interface Adaptors; Serial Communication Interface; Examples of Interfacing; Problems.

Design and Mechatronics: Design Process; Traditional and Mechatronics Design; Possible Mechatronics design solutions for Timed Switch, Wind Screen Wiper Motion, Bath Room Scale, A Pick & Place Robot, Automatic Camera, Engine Management System & Bar Code Recorder.

Text and Reference Books

1. Mechatronics by W. Bolton, Published by Addition Wesley.
2. Mechatronics System Design – Devdas Shetty and Richard A. Kolx Brooks/ Cole.
3. Introduction to Mechatronics and Measuring System: david G. Alciation and Michael B. Hist and Tata McGraw Hill.
4. Mechtronics – Sensing to Implementation - C.R.Venkataraman, Sapna .

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	2	--	--	1	2	2	3	3	2	2
CO2	3	1	2	2	2	2	--	--	2	2	2	3	3	2	2
CO3	3	2	3	3	2	2	--	--	2	3	2	3	3	2	3
CO4	3	2	2	2	3	2	--	--	1	3	2	3	3	2	2
CO5	3	2	3	3	2	2	--	--	2	3	2	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

AUTOMATIC CONTROL (THEORY)

General Course Information

Course Code: PEC-ME461-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe the control system, controller and applications of control systems	L1
CO2	Students will be able to understand response analysis and stability criteria of control system.	L2
CO3	Students will be able to integrate mechanical, electronics, instrumentation, computer and controls fields.	L3
CO4	Students will be able to evaluate the performance of control system	L4

Course Content

UNIT-I

Introduction: Types of control systems; Typical Block Diagram: Performance Analysis; Representation of Processes & Control Elements – Mathematical Modeling. Block Diagram Representation, Representation of Systems or Processes, Comparison Elements; Representation of Feedback Control systems – Block Diagram & Transfer Function Representation, Representation of a Temperature Control System, Signal Flow Graphs, Problems.

Types of Controllers: Introduction: Types of Control Action; Hydraulic Controllers; Electronic Controllers; Pneumatic Controllers; Problems.

UNIT-II

Transient And Steady State Response: Time Domain Representation; Laplace Transform Representation; System with Proportional Control; Proportional–cum–Derivative control; Proportional–cum–Integral Control; Error Constants; Problems.

Frequency Response Analysis: Introduction; Closed and Open Loop Transfer Function; Polar Plots; Rectangular Plots; Nichols Plots: Equivalent Unity Feed Back Systems; Problems.

UNIT-III

Stability of Control Systems: Introduction; Characteristic Equation; Routh's Criterion; Nyquists Criterion, Gain & Phase Margins: Problems.

Root Locus Method: Introduction; Root Ioci of a Second Order System; General Case; Rules for Drawing Forms of Root Ioci; Relation between Root Locus Locations and Transient Response; Parametric Variation; Problems.

UNIT-IV

State Space Analysis of Control Systems: Introduction; Generalized State Equation; Techniques for Deriving System State – Space Equations; Transfer Function from State Equations; Solution of State Vector Differential Equations; Discrete Systems; Problems.

Applications of automatic control – Machine Tool Control, Boiler Control, Engine Governing, Aerospace Control, Active Vibration Control and other control systems

Text and Reference Books

1. Theory & Applications of Automatic Controls by B.C. Nakra, Published by New Age International Pvt. Ltd. Publishers, 2014, New Delhi.
2. Modern Control Engg. by Ugata, Prentice Hall of India, 2012, New Delhi.
3. Automatic Control Systems by Kuo' Published by Prentice Hall of India, 2007, New Delhi.
4. Control System Engineering, I. J. Nagrath and M. Gopal, New Age International Pvt. Ltd. Publishers, 2012, New Delhi.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	--	2	--	--	--	1	2	3	3	3	1
CO2	3	2	2	2	2	2	--	--	--	1	2	2	1	3	2
CO3	3	2	2	1	2	3	1	1	3	2	2	2	2	3	2
CO4	2	1	1	--	3	3	1	--	2	2	2	2	1	1	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

FLEXIBLE MAUFACTURING SYSTEM (THEORY)

General Course Information

Course Code: PEC-ME462-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to recall basic automation, types of automation and transfer mechanism	L1
CO2	Students will be able to classify different automated assembly systems, quantitative and operational analysis of assembly machine.	L2
CO3	Students will be able to apply the technology, optimum machine arrangement & benefits of group technology.	L3
CO4	Students will be able to examine robotics, material handling, computer-controlled system with their application & benefits.	L4
CO5	Students will be able to formulate a flexible manufacturing systems.	L5

Course Content

UNIT-I

Automation: Types of automation, reasons for automating, automation strategies, Detroit-type automation: Automated flow lines, methods of work part transport, Transfer mechanisms, buffer storage, automation for machining operations.

Automated assembly systems: Design for automated assembly, types of automated assembly systems, part feeding devices, quantitative analysis of the delivery system operation, analysis of a single-station assembly machine, numericals.

UNIT-II

Group Technology: Part families, parts classification and coding, types of classification and coding systems. Machine cell design: The composite part concept, types of cell designs, determining the best machine arrangement, benefits of group technology.

Flexible Manufacturing Systems: Components of an FMS, types of systems, where to apply FMS technology, FMS work stations. Material handling and storage system: Functions of the handling system, FMS layout configurations. Material handling equipment. Computer control system: Computer function, FMS data file, system reports. Planning the FMS, analysis methods for FMS, applications and benefits.

UNIT-III

Robotic technology: Joints and links, common robot configurations, work volume, types of robot control, accuracy and repeatability, other specifications, end effectors, sensors in robotics.

UNIT-IV

Robot programming: Types of programming, lead through programming, motion Programming, interlocks, advantages and disadvantages. Robot languages: Motion programming, simulation and off-line programming, work cell control.

Robot applications: Characteristics of robot applications, robot cell design, types of robot applications: Material handling, processing operations, assembly and inspection.

Text and Reference Books:

1. Automation, Production Systems and Computer Integrated Manufacturing. Groover M.P, Prentice Hall of India.
2. CAD/CAM – Groover M.P, Zimmers E.W, Prentice Hall of India..
3. Approach to Computer Integrated Design and Manufacturing Nanua Singh, John Wiley and Sons, 1998.
4. Production Management Systems: A CIM Perspective Browne J, Harhen J, Shivnan J, Addison Wesley, 2nd Ed. 1996.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	1	1	1	2	1	2	3	3	3	2
CO2	3	3	3	2	--	1	1	1	2	1	2	3	3	3	3
CO3	3	3	3	2	--	1	1	1	2	1	2	3	3	3	2
CO4	3	3	3	2	--	1	1	1	2	1	2	3	3	3	2
CO5	3	3	3	2	--	1	1	1	2	1	2	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

RAPID PROTOTYPING (THEORY)

General Course Information

Course Code: PEC-ME463-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn need & development, benefits and applications of Rapid Prototyping systems.	L1
CO2	Students will be able to understand different types of Rapid Prototyping processes like 3D printing, Stereolithography, Selective Laser Sintering, Laminated Object Modeling and Fusion Deposition Modeling, Electron Beam Melting.	L2
CO3	Students will be able to point out the applications of Rapid Prototyping particularly in product design & development, medical, tooling, fashion & jewellery, architecture and automotive fields.	L3
CO4	Students will be able to define virtual prototyping and identify simulation components.	L4

Course Content

UNIT-I

Introduction to RP: Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Digital prototyping, Virtual prototyping.

RP Applications: Design, Concept Models, Form & fit checking, Ergonomic Studies, Functional testing, Requesting Price quotes, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, Archeology, Paleontology & forensic Science, miniaturization.

UNIT-II

Liquid and Solid Based Rapid Prototyping Systems: Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, 3D printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Powder Based Rapid Prototyping Systems: Selective Laser Sintering, Direct Metal Laser Sintering, 3D Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations.

UNIT-III

Data Processing for Rapid Prototyping: Process planning for rapid prototyping, CAD model preparation, Data Requirements & geometric modeling techniques: Wire frame, surface and solid modeling data formats - Data interfacing, Tessellation of surfaces, STL file generation Defects in STL files and repairing algorithms, Part orientation

and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

Issues of Rapid Prototyping parts: Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost, material, color, dimensional accuracy, stability, machine-ability, environmental resistance, operational properties.

UNIT-IV

Rapid Tooling: Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting, use of Rapid tooling for injection mold.

Reverse Engineering: Introduction to reverse engineering, integration of reverse engineering and rapid prototyping, use of RP for reverse engineering.

Text and Reference Books

1. Rapid Prototyping: Principle and Applications, Rafiq I Noorani, Wiley & Sons, 2006
2. Rapid prototyping: Principles and applications, Chua C.K., Leong K.F., and Lim C.S., Yes Dee Publishing Pvt. Ltd, Third edition,2010.
3. Rapid Prototyping And Engineering Applications, Frank W. Liou, CRC Press, Special Indian Edition, 2007.
4. Journey from Rapid Prototyping to Rapid Manufacturing , Somnath Chattopadhyaya, LAP Lambert Academic Publishing,,2011.
5. Rapid Prototyping Technology: Selection and Application, Kenneth G. Cooper, Cooper Cooper, Marcel Dekker Inc, 1st Edition, 2001.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	--	--	--	2	--	--	--	--	--	--	3	3	2	1
CO2	3	--	--	--	2	--	--	--	--	--	--	3	3	2	1
CO3	3	3	3	--	2	--	--	--	--	--	2	3	3	2	2
CO4	3	--	2	--	3	--	--	--	--	--	2	3	3	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -V

Course Code	Course Name	L	T	P	Credits
PEC-ME464-T	Power Plant Engineering	3	-	-	3.0
PEC-ME465-T	Solar Energy Engineering	3	-	-	3.0
PEC-ME466-T	Design of Heat Exchangers	3	-	-	3.0
PEC-ME467-T	Turbo Machinery	3	-	-	3.0
PEC-ME468-T	Computational Fluid Dynamics	3	-	-	3.0

POWER PLANT ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME464-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and state various thermal power plants.	L1
CO2	Students will be able to classify, compare and explain different power plants.	L2
CO3	Students will be able to demonstrate the constructional details and working principle of power plants.	L3
CO4	Students will be able to differentiate conventional/non-conventional/ direct energy conversion devices and power plants.	L4
CO5	Students will be able to evaluate the performance, operating characteristics and electrical energy costing of a given thermal power plants.	L5

Course Content

UNIT-I

Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.

Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

UNIT-II

Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.

Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles. Problems.

UNIT-III

Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.

Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-out put curves, efficiency, heat rate, economic load sharing, Problems.

UNIT-IV

Non-Conventional Power Generation: Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.

Direct Energy Conversion Systems: Fuel cell, MHD power generation-principle, open & closed cycles systems, thermoelectric power generation, thermionic power generation.

Text and Reference Books

1. Power Plant Engineering –Arora & Domkundwar, Dhanpat Rai & Co, 2011.
2. Power Plant Engineering –Samsher Gautam, Vikash publications, 2013.
3. Power Plant Engineering –P.C. Sharma, Katson Books, 2010.
4. Power Plant Engineering –G.D. Rai, Khanna Publishers, 2010.
5. Power Plant Engineering –R.K. Rajput, Laxmi Publishers, 2012.
6. Power station Engineering and Economy by B. G.A. Skrotzki and W.A. Vopat, Mc Graw Hill Publishing Campany Ltd., New Delhi.
7. Power Plant Engineering- P.K. Nag Tata McGraw Hill second Edition, 2001.
8. Power Plant Engg.- M.M. El-Wakil McGraw Hill, 1985.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO2	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO3	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	2	1	--	2	1	1	2	2	2	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

SOLAR ENERGY ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME465-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to state heating/cooling and electrical applications of solar engineering.	L1
CO2	Students will be able to classify and explain different solar energy based devices/equipments and their effects on environment.	L2
CO3	Students will be able to use different solar based equipments/appliances for various domestic applications.	L3
CO4	Students will be able to examine performance of various solar engineering equipments/devices.	L4
CO5	Students will be able to evaluate the thermal performance of solar based equipments.	L5

Course Content

Unit- I

Introduction to solar system: Introduction, solar system – sun, earth and earth-sun angles, time, derived solar angles,

Solar Radiation: Estimation of solar radiation (direct and diffuse), measurement systems – phyrheliometers and other devices.

Unit-II

Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces, shading of surfaces, periodic heat transfer through walls and roofs.

Solar Collectors: Flat plate and concentrating – comparative study, design and materials, efficiency, selective coatings, heliostats.

Unit-III

Heating Applications of Solar Energy: Air and Water heating systems, thermal storages, solar ponds, solar pumps, solar lighting systems, solar cookers, solar drying of grains.

Cooling Applications of Solar Systems: Continuous and intermittent vapour absorption systems for cooling applications, absorbent – refrigerant combination, passive cooling systems.

Unit-IV

Solar Electric Conversion Systems: Photovoltaics, solar cells, satellite solar power systems.

Effects on Environment: economic scenario, ozone layer depletion, green house effect, global warming, Remedial measures by international bodies.

Text and Reference Books

1. Solar Energy: Fundamentals, Design, Modelling and Applications - GN Tiwari, CRC Press
2. Solar Energy – S P Sukhatme, Tata McGraw Hill
3. Solar Energy Process – Duffie and Bechman, John Wiley
4. Applied Solar Energy – Maniel and Maniel, Addison Wiley
5. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO2	3	3	2	1	--	2	3	1	1	2	1	3	3	3	3
CO3	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO4	3	3	3	1	--	2	2	1	1	2	1	3	3	3	2
CO5	3	3	3	1	--	2	2	1	2	2	1	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

DESIGN OF HEAT EXCHANGERS (THEORY)

General Course Information

Course Code: PEC-ME466-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and state heat exchangers used in various engineering applications.	L1
CO2	Students will be able to classify, compare and explain different heat exchangers.	L2
CO3	Students will be able to solve the problems related to the design parameters of a heat exchanger.	L3
CO4	Students will be able to differentiate and examine various heat exchangers.	L4
CO5	Students will be able to evaluate the thermal performance/sizing/heat transfer coefficients of a heat exchanger.	L5

Course Contents

UNIT-I

Classification of Heat exchangers: Introduction, Recuperation and regeneration, Transfer processors, Geometry of construction–tubular heat exchangers, plate heat exchangers, extended surface heat exchanges, Heat transfer mechanisms, Flow arrangements, Selection of heat exchangers.

Basic Design Methods of Heat Exchanges: Introduction, Arrangement of flow path in heat exchangers , Basic equations in design, Overall heat transfer coefficient , Log mean temperature difference method for heat exchanger analysis, The $\mathcal{E}$-NTU method for heat exchanger analysis, Heat exchanger design calculation, Variable overall heat transfer coefficient , Heat exchanger design methodology.

UNIT-II

Design Correlations for Condensers and Evaporators: Introduction, Condensation, Film condensation on a single horizontal tube-laminar film condensation, forced convection, Film condensation in tube bundles-effect of condensate inundation, effect of vapor shear, Combined effects of inundation and vapor shear, Condensation inside tubes-condensation in vertical tubes, Flow boiling-subcooled boiling, flow pattern, flow boiling correlations.

Shell and Tube Heat Exchangers: Introduction, Basic components-shell types, tube bundle types, tubes and tube passes, tube layout, baffle type and geometry, allocation of streams, Basic design procedure of a heat exchanger-preliminary estimation of unit size, rating of preliminary design, Shell-slide heat transfer and pressure drop-shell-side heat transfer coefficient, shell-side pressure drop, tubeside pressure drop, Bell-Delaware method.

UNIT-III

Compact Heat Exchangers: Introduction, Plate-fin heat exchangers, tube-fin heat exchangers, Heat transfer and pressure drop-heat transfer, pressure drop for finned-tube exchangers, pressure drop for plate-fin exchangers.

Gasketed Plate Heat Exchangers: Introduction, Mechanical features-plate pack and frame, plate types, Operational characteristics-main advantages, performance limits, Passes and flow arrangements, Application-corrosion, maintenance, Heat transfer and pressure drop calculations heat transfer area, mean flow channel gap, channel equivalent diameter, heat transfer coefficient, channel pressure drop, port pressure drop, overall heat transfer coefficient, heat transfer surface area, performance analysis, Thermal performance.

UNIT-IV

Condensers and Evaporators: Introduction, Shell-and-tube condensers-horizontal shell-side condensers, vertical shell-side condensers, vertical tube-side condensers, horizontal in-tube condensers, Steam turbine exhaust condensers, Plate condensers, Air-cooled condensers, Direct contact condensers, Thermal design of shell-and-tube condensers, Design and operational considerations, Condensers for refrigeration and air-conditioning-water cooled condensers, aircooled condensers, evaporative condensers, Evaporative for refrigeration and airconditioning-water-cooling evaporators (chillers), air-cooling evaporators (air coolers), Thermal analysis-shah correlation, Kandlikar correlation, Gungor and Winterton correlation, Standards for evaporators and condensers.

Regenerators: Classifications-fixed bed regenerators, rotary regenerators, basic design method, Influence of fluid bypass carry-over, Pressure drop evaluation, The rating problem, surface geometrical properties, Pressure drop, Sizing problem.

Text and Reference Books

1. Compact Heat Exchangers: Selection, Application, Design and Evaluation, Bahman Zohuri, 2017.
2. Heat Exchanger Design Guide – practical guide for planning, selecting and designing of shell and tube exchangers, Dr. Manfred Nitsche and Mr. R.O. Gbadamosi, Essevier, 2015.
3. Heat Exchanger Design Handbook, Second Edition,Kuppan Thulukkanam, CRC press, 2013.
4. Fundamentals of heat exchanger design, R.K. Shah, Jon Wily & Sons, 2003.
5. Fundamentals of heat exchanger design, Ramesh K. Shah, Dusan P. Sekulic, John Wiley & Sons, 2003.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO2	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO3	3	3	3	1	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	1	--	2	1	1	2	2	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

TURBO MACHINERY (THEORY)

General Course Information

Course Code: PEC-ME467-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define application of thermodynamics and fluid mechanics.	L1
CO2	Students will be able to describe the analyses of practical gas turbine and propulsion cycles.	L2
CO3	Students will be able to examine the performance characteristics of gas turbines	L3
CO4	Students will be able to develop different turbo machineries.	L4

Course Content

UNIT-I

Review of Basics: Introduction to Prime Movers, Gas Turbines, Review of Basic principles – Thermodynamics, Review of Basic principles – Fluid Dynamics and Heat Transfer, Fundamentals of Rotating Machines – Energy Equation, Dimensional Analysis, Airfoil Theory.

Ideal Gas Turbine Cycles: Analysis of Ideal Gas Turbine Cycles, Simple Cycle, Regeneration Cycle, Reheat Cycle, Inter cooling Cycle.

UNIT-II

Practical Gas Turbine Cycles: Analysis of Practical Gas Turbine Cycles, Methods of accounting for component losses, Efficiencies, changes in the composition of the working fluid.

Propulsion Cycles: Jet Propulsion Cycles and their Analysis for turbojet, turboprop and turbofan engines-efficiency and specific thrust Factors Affecting Flight Performance & Methods of Thrust Augmentation.

UNIT-III

Gas Turbines: Axial Flow Gas Turbines – Impulse and reaction Turbines, Single Impulse stage, Single Reaction stage, Performance characteristics.

Rankine Cycle: Properties of Pure Substances, Property diagrams, Steam Power plant Layout, Rankine Cycle-Analysis, Modified Rankine Cycle, and Combined Cycle.

UNIT-IV

Steam Nozzles: Steam Nozzles: Introduction, Area- velocity relationship, Mass flow rate, Choking of Nozzles, Performance characteristics of Nozzles, Super saturated flow Steam Turbines: Steam Turbines : Impulse and reaction

Turbines, Compounding of steam turbines, Multistage reaction Turbines, Reheat factor and Efficiency, Governing of Steam Turbines

Text and Reference Books

1. Principles of turbomachinery, Seppo A. Korpela, Wiley, 2011.
2. Fundamentals of turbomachinery, B.K. venkanna, PHI, 2009
3. Fundamentals of turbomachinery, William W.Peng, Willey, 2007.
4. Turbomachinery: Physics and Dynamics, Meinhard T. Schobeiri, Springer, 2005.
5. Tribo-Machinery Dynamics, A.S. Rangwala, Mc Graw Hill, 2005.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	1	1	1	1	2	1	3	3	3	1
CO2	3	3	3	2	--	1	1	1	1	2	1	3	3	3	1
CO3	3	3	3	2	--	1	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	1	1	1	1	2	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

COMPUTATIONAL FLUID DYNAMICS (THEORY)

General Course Information

Course Code: PEC-ME468-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the fundamental of CFD and its various approach.	L1
CO2	Students will be able to understand the governing equations for heat and fluid flow.	L2
CO3	Students will be able to solve the heat transfer and fluid flow problem using CFD	L3
CO4	Students will be able to compare the finite volume and finite difference methods	L4

Course Contents

UNIT-I

Introduction: Introduction to C.F.D., models of the flow, governing differential equations – continuity equation, momentum equation, energy equation, Navier- stokes equation, physical boundary conditions.

Mathematical behavior of governing equation: Classification of quasi linear partial differential equation, General method of determining the Classification of partial differential equation, hyperbolic, parabolic, elliptic equations.

UNIT-II

Heat conduction problem: Solution of One dimensional heat conduction through a pin fin by F.D.M solution of two dimensional heat conductional in a plate by F.D.M. Control volume formulation of the heat conduction problem and its solution. Discretization methods: Finite difference methods, difference equations, explicit & implicit approach, errors & analysis of stability. Basics of finite control volume method, errors & analysis of stability

UNIT-III

Heat conduction with convection & diffusion: Steady state one dimensional convection and diffusion, unwinding, exact solution, exponential scheme, hybrid scheme, power law scheme, Discretization equation for two dimensions & three dimensions, false diffusion

UNIT-IV

Fluid flow problem: Viscous incompressible flow, solution of the couette flow problem by F.D.M., calculation of the flow field using stream function –vorticity method numerical algorithms for solving complete navier stokes equation – MAC method; SIMPLE method.

Text and Reference Books

1. Versteeg, H. and Malalasekra, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Education, New Delhi (2008).
2. Wendt, J. F., Computational Fluid Dynamics: An Introduction, Springer, New York (2009)
3. Muralidhar, K and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa, New Delhi
4. Jaluria, Y and Torrance, K.E., Computational Heat Transfer, Hemisphere Publishing Company, New York
5. Patankar, S. V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Company, New York
6. John David Anderson, Computational Fluid Dynamics: The Basics with Applications, Mcgraw hill education

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	3	1	1	--	--	2	1	3	3	2	3
CO2	3	1	2	2	2	--	1	1	2	2	--	3	3	2	2
CO3	3	3	2	3	3	2	2	1	2	2	--	3	2	1	2
CO4	3	2	--	2	3	--	--	--	2	2	--	3	--	--	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)