Scheme and Syllabus

for

B. Tech. Mechanical Engineering

for

Working Professionals

(w.e.f. 2023-2024)

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 exemplaryprofessional 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 for Working Professionals (2023-2024 onwards)

Credit Score

(i) Category wise

S. No.	Category	Category Code	Credits
1	Humanities and Social Sciences including Management Courses	HSMC	06
2	Basic Science Courses	BSC	03
3	Engineering Science Courses	ESC	04
4	Professional Core Courses	PCC	80
5	Professional Elective Courses	PEC	17
6	Open Elective	OE	03
7	Project work, Seminar and Internship in Industry	PROJ	04
8	Mandatory Courses	MC	03
Total			**120**

(ii) Semester wise

Semester	Credits
3rd	20.0
4th	20.0
5th	20.0
6th	20.0
7th	20.0
8th	20.0
Total	**120.0**

Course list Category Wise

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

Sr. No.	Semester	Course Title	Course Credits
1.	6th	Fundamental of Management (Theory)	3.0
2.	7th	Economics for Engineers (Theory)	3.0
Total Credits			**6.0**

(ii) Basic Science Courses (BSC)

Sr. No.	Semester	Course Title	Course Credits
1.	3rd	Numerical Methods (Theory)	3.0
Total Credits			**3.0**

(iii) Engineering Science Courses (ESC)

Sr. No.	Semester	Course Title	Course Credits
1.	3rd	Engineering Mechanics (Theory)	4.0
Total Credits			**4.0**

(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)	4.0
4.	4th	Material Science (Theory and Lab)	5.0
5.		Fluid Mechanics (Theory and Lab)	5.0
6.		Computer Aided Design (Theory and Lab)	4.0
7.		Mechanics of Solids-II (Theory)	3.0
8.		Measurement and Instrumentation (Theory)	3.0
9.	5th	Kinematics of Machines (Theory and Lab)	5.0
10.		Hydraulic Machines (Theory and Lab)	5.0
11.		Design of Machine Elements (Theory)	4.0
12.	6th	Dynamics of Machines (Theory and Lab)	5.0
13.		Computer Aided Manufacturing (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.		Industrial Engineering (Theory)	4.0
17.	8th	Renewable Energy (Theory)	3.0
18.		Industry 4.0 (Theory and Lab)	4.0
19.		Mechanical Vibration (Theory)	3.0
Total Credits			**80.0**

(v) Professional Elective Courses (PEC)

Sr. No.	Semester	Course Title	Course Credits
		Professional Elective-I	**3.0**
1.	5th	Statistical Quality Control (Theory)	
2.		Production Management (Theory)	
3.		Operation Research (Theory)	
		Professional Elective-II	**3.0**
4.	6th	Automation in Manufacturing (Theory)	
5.		Modern Machining Processes (Theory)	
6.		Reverse Engineering (Theory)	
7.		Micro and Nano Manufacturing (Theory)	
		Professional Elective-III	**3.0**
8.	7th	Production Planning and Cost Control (Theory)	
9.		Modeling Simulation and Optimization (Theory)	
10.		Tool Engineering (Theory)	
		Professional Elective-IV	**5.0**
11.	7th	Stainless Steel Manufacturing (Theory and Lab)	
12.		Automobile Engineering (Theory and Lab)	
13.		Tribology (Theory and Lab)	
14.		Power Plant Engineering (Theory and Lab)	
		Professional Elective-V	**3.0**
15.	8th	Industrial Hydraulics and Pneumatics (Theory)	
16.		Automatic Control (Theory)	
17.		Mechatronics (Theory)	
Total Credits			**17.0**

(vi) Open Elective (OE)

Sr. No.	Semester	Course Title	Course Credits
		Open Elective-I	**3.0**
1.	7th	Artificial Intelligence and Machine Learning (Theory)	
2.		Introduction to MATLAB and Simulink (Theory)	
3.		Energy Management and Audit (Theory)	
Total Credits			**3.0**

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

Sr. No.	Semester	Course Title	Course Credits
1.	8th	Project	3.0
2.		Technical Presentation	1.0
Total Credits			**4.0**

(viii)Mandatory Courses (MC)

Sr. No.	Semester	Course Title	Course Credits
1.	5th	Environmental Science (Theory)	3.0
Total Credits			**3.0**

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

B.Tech. (Mechanical Engineering) Programme for Working Professionals

III- Semester

Sr. No.	Course Code	Course Title	Hours per week			Course Credits	Maximum Marks		
			L	T	P		Internal	External	Total
1.	MEWP-201-T	Engineering Mechanics	4	0	0	4.0	30	70	100
2.	MEWP-203-T	Mechanics of Solids-I	4	0	0	4.0	30	70	100
3.	MEWP-203-P	Mechanics of Solids-I Lab	0	0	2	1.0	50	50	100
4.	MEWP-205-T	Production Technology	3	0	0	3.0	30	70	100
5.	MEWP-205-P	Production Technology Lab	0	0	2	1.0	50	50	100
6.	MEWP-207-T	Thermodynamics	4	0	0	4.0	30	70	100
7.	MEWP-209-T	Numerical Methods	3	0	0	3.0	30	70	100
Total			18	0	4	20.0	250	450	700

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

B.Tech. (Mechanical Engineering) Programme for Working Professionals

IV- Semester

Sr. No.	Course Code	Course Title	Hours per week			Course Credits	Maximum Marks		
			L	T	P		Internal	External	Total
1.	MEWP-202-T	Material Science	4	0	0	4.0	30	70	100
2.	MEWP-202-P	Material Science Lab	0	0	2	1.0	50	50	100
3.	MEWP-204-T	Fluid Mechanics	4	0	0	4.0	30	70	100
4.	MEWP-204-P	Fluid Mechanics Lab	0	0	2	1.0	50	50	100
5.	MEWP-206-T	Computer Aided Design	3	0	0	3.0	30	70	100
6.	MEWP-206-P	Computer Aided Design Lab	0	0	2	1.0	50	50	100
7.	MEWP-208-T	Mechanics of Solids-II	3	0	0	3.0	30	70	100
8.	MEWP-210-T	Measurement and Instrumentation	3	0	0	3.0	30	70	100
Total			17	0	6	20.0	300	500	800

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

B.Tech. (Mechanical Engineering) Programme for Working Professionals

V- Semester

Sr. No.	Course Code	Course Title	Hours per week			Course Credits	Maximum Marks		
			L	T	P		Internal	External	Total
1.	MEWP-301-T	Kinematics of Machines	4	0	0	4.0	30	70	100
2.	MEWP-301-P	Kinematics of Machines Lab	0	0	2	1.0	50	50	100
3.	MEWP-303-T	Hydraulic Machines	4	0	0	4.0	30	70	100
4.	MEWP-303-P	Hydraulic Machines Lab	0	0	2	1.0	50	50	100
5.	MEWP-305-T	Design of Machine Elements	4	0	0	4.0	30	70	100
6.	MEWP-307-T	Environmental Science	3	0	0	3.0	30	70	100
7.	MEWP (refer to list)*	*Professional Elective –I	3	0	0	3.0	30	70	100
Total			18	0	4	20.0	250	450	700

*Professional Elective –I	
Course Code	Course Name
MEWP-309-T	Statistical Quality Control
MEWP-311-T	Production Management
MEWP-313-T	Operation Research

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

B.Tech. (Mechanical Engineering) Programme for Working Professionals

VI- Semester

Sr. No.	Course Code	Course Title	Hours per week			Course Credits	Maximum Marks		
			L	T	P		Internal	External	Total
1.	MEWP-302-T	Fundamental of Management	3	0	0	3.0	30	70	100
2.	MEWP-304-T	Dynamics of Machines	4	0	0	4.0	30	70	100
3.	MEWP-304-P	Dynamics of Machines Lab	0	0	2	1.0	50	50	100
4.	MEWP-306-T	Computer Aided Manufacturing	3	0	0	3.0	30	70	100
5.	MEWP-306-P	Computer Aided Manufacturing Lab	0	0	2	1.0	50	50	100
6.	MEWP-308-T	Heat Transfer	4	0	0	4.0	30	70	100
7.	MEWP-308-P	Heat Transfer Lab	0	0	2	1.0	50	50	100
8.	MEWP (refer to list)*	*Professional Elective –II	3	0	0	3.0	30	70	100
Total			17	0	6	20.0	300	500	800

*Professional Elective -II	
Course Code	Course Name
MEWP-310-T	Automation in Manufacturing
MEWP-312-T	Modern Machining Processes
MEWP-314-T	Reverse Engineering
MEWP-316-T	Micro and Nano Manufacturing

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

B.Tech. (Mechanical Engineering) Programme for Working Professionals

VII- Semester

Sr. No.	Course Code	Course Title	Hours per week			Course Credits	Maximum Marks		
			L	T	P		Internal	External	Total
1.	MEWP-401-T	Refrigeration and Air-Conditioning	4	0	0	4.0	30	70	100
2.	MEWP-401-P	Refrigeration and Air-Conditioning Lab	0	0	2	1.0	50	50	100
3.	MEWP-403-T	Industrial Engineering	4	0	0	4.0	30	70	100
4.	MEWP-405-T	Economics for Engineers	3	0	0	3.0	30	70	100
5.	MEWP (refer to list)*	*Professional Elective –III	3	0	0	3.0	30	70	100
6.	MEWP (refer to list)*	*Professional Elective –IV	4	0	0	4.0	30	70	100
7.		*Professional Elective Lab –IV	0	0	2	1.0	50	50	100
Total			18	0	4	20	250	450	700

*Professional Elective –III	
Course Code	Course Name
MEWP-407-T	Production Planning and Cost Control
MEWP-409-T	Modeling Simulation and Optimization
MEWP-411-T	Tool Engineering

*Professional Elective –IV	
Course Code	Course Name
MEWP-413-T	Stainless Steel Manufacturing
MEWP-413-P	Stainless Steel Manufacturing Lab
MEWP-415-T	Automobile Engineering
MEWP-415-P	Automobile Engineering Lab
MEWP-417-T	Tribology
MEWP-417-P	Tribology Lab
MEWP-419-T	Power Plant Engineering
MEWP-419-P	Power Plant Engineering Lab

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

B.Tech. (Mechanical Engineering) Programme for Working Professionals

VIII- Semester

Sr. No.	Course Code	Course Title	Hours per week			Course Credits	Maximum Marks		
			L	T	P		Internal	External	Total
1.	MEWP-402-T	Renewable Energy	3	0	0	3.0	30	70	100
2.	MEWP-404-T	Industry 4.0	3	0	0	3.0	30	70	100
3.	MEWP-404-P	Industry 4.0 Lab	0	0	2	1.0	50	50	100
4.	MEWP-406-T	Mechanical Vibration	3	0	0	3.0	30	70	100
5.	MEWP (refer to list)*	*Professional Elective -V	3	0	0	3.0	30	70	100
6.	MEWP (refer to list) #	# Open Elective-I	3	0	0	3.0	30	70	100
7.	MEWP-408-P	Project	0	0	6	3.0	50	50	100
8.	MEWP-410-P	Technical Presentation	0	0	2	1.0	100	---	100
Total			15	0	10	20.0	350	450	800

*Professional Elective –V	
Course Code	Course Name
MEWP-412-T	Industrial Hydraulics and Pneumatics
MEWP-414-T	Automatic Control
MEWP-416-T	Mechatronics

# Open Elective –I	
Course Code	Course Name
MEWP -492-T	Artificial Intelligence and Machine Learning
MEWP -494-T	Introduction to MATLAB and Simulink
MEWP -496-T	Energy Management and Audit

3rd Semester

ENGINEERING MECHANICS

General Course Information

Course Code: MEWP-201-T Course Category: Engineering Science Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to describe force systems, centroid, moment of inertia, frames, dynamics of a particle, friction, virtual work etc.	L1
CO2	Students will be able to solve the problems related to centroid, trusses and frames.	L2
CO3	Students will be able to interpret the given dynamic problems and apply principles of friction in engineering 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
CO5	Students will be able to solve complex engineering problems by applying principles of engineering, science, and mathematics.	L5

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,Tension in a string carrying point loads, Tension in a string carrying uniformly distributed load. 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, Cantilever 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

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

UNIT-IV

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

Collision of Elastic Bodies: Introduction, Phenomenon of Collision, Law of Conservation of Momentum, Newton's law of Collision of Elastic Bodies, Coefficient of Restitution, Types of Collisions, Loss of Kinetic Energy During Collision.

Text and Reference Books

1. Irving H. Shames (2006), 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

General Course Information

Course Code: MEWP-203-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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: 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 and Shearing stresses in beams: Theory of simple bending, position of neutral axis, flitched beams, shearing stress variation in beams 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, 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: MEWP-203-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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
CO5	Students will be able to design mechanical elements by understanding mechanical behavior and failure criterions of materials under different loading conditions.	L5

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
CO5	2	1	--	--	--	--	--	--	1	1	2	3	3	3	2

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

PRODUCTION TECHNOLOGY

General Course Information

Course Code: MEWP-205-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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 manufacturing processes utilized in different manufacturing industries.	L2
CO3	Students will be able to examine different kind of problems related to tools and manufacturing methods selection.	L3
CO4	Students will be able to compare 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, 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, 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, Machinability.

UNIT-II

Metal Forming Processes: Nature of plastic deformation, hot working and cold working, Principles of rolling, roll passes, roll pass sequences. Forging: Forging operations, smith forging, drop forging, press forging, forging defects.

Extrusion and other processes: Extrusion principle, hot extrusion, cold extrusion, wire drawing, tube making. Sheet metal operations: Press tools operations, drawing dies, spinning, bending, stretch forming, embossing and coining.

UNIT-III

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

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

UNIT-IV

Non-Conventional Machining: Introduction, Classification of Non-Conventional Machining Processes, Process Selection, Ultrasonic Machining, Abrasive Jet 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. 2nd edition, 1999.
2. Production Technology: P.C. Sharma, S. Chand Publication8th edition, 2014
3. Production Technology: O.P. Khanna, Dhanpat Rai Publication, 2012
4. Principles of metal cutting: Sen and Bhattacharya, New Central Book. 2nd edition, 1969.
5. Metal cutting principles: Shaw, MIT Press Cambridge, 2nd edition, 2004.
6. Modern machining processes: Pandey and Shan, Tata McGraw Hill Publications, 2017
7. Manufacturing analysis: Cook, Adisson-Wesley, 1st edition, 1966

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: MEWP-205-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 04 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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

General Course Information

Course Code: MEWP-207-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the basic terms and sign-convections involved in heat and work interactions.	L1
CO2	Students will be able to extend their knowledge from low to high grade energies.	L2
CO3	Students will be able to solve basic problems of thermodynamic.	L3
CO4	Students will be able to calculate the efficiency of different thermodynamic devices.	L4
CO5	Students will be able to discuss the construction and working of steam generators, steam turbines and steam condensers.	L5
CO6	Students will be able to solve the practical problems directed to the designing of an effective thermodynamic system.	L6

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, 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-II, Carnot Cycle, Carnot Heat Engine and Carnot Heat Pump, Carnot Theorem and its Corollaries, 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, 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, law of corresponding states, Mixture of Gases, Mass, Mole and Volume Fraction, Gibson Dalton's law, Gas Constant and Specific Heats,. 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

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.

Steam Turbines and Condensers: 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, 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. Thermal Science and Engineering – Dr. D.S. Kumar, Katson Books, 2021.
2. Essentials of Engineering Thermodynamics- Clement Kleinstreuer, McGraw Hill, 2021.
3. Thermodynamics: An Engineering Approach- Yunus Cengel and Michael Boles, Tata McGraw Hill, 9th edition. 2019
4. Fundamentals of Engineering Thermodynamics - Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, Wiley, 9th edition. 2018
5. Engineering Thermodynamics - P K Nag, Tata McGraw Hill, 6th 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	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
CO5	3	3	2	1	--	2	3	1	1	2	1	3	3	3	3
CO6	3	3	3	3	--	3	1	1	2	2	2	3	3	3	2

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

NUMERICAL METHODS

General Course Information

Course Code: MEWP-209-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.	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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: 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.

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.

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.

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)

4th Semester

MATERIAL SCIENCE

General Course Information

Course Code: MEWP-202-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 3 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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 ofmaterials & 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 analyze the materials using metallography and characterization techniques.	L4
CO5	Students will be able to evaluate the properties and applications of various composite materials.	L5

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 & Composite Materials: Definition and concept, creep curve, mechanism of creep, impact of time and temperature on creep, creep fracture, creep testing and prevention against creep, Introduction to composite materials, Types, advantages, disadvantages and their applications.

Fundamental properties and Characterization of biomaterials: Introduction of biomaterials, Types of biomaterial, Basic properties of materials, Infrared spectroscopy, E-ray photo-electron spectroscopy, Atomic force microscopy, Scanning electron microscopy (SEM), FESEM, Transmission electron microscopy (TEM), X-ray diffraction (XRD), Micro-hardness, surface roughness.

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
CO5	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: MEWP-202-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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 the materials using metallography and characterization techniques.	L4
CO5	Students will be able to evaluate the crystals imperfections.	L5

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 the creep behavior of a given specimen.
8. To study Bravais lattices with the help of models.
9. To study crystal structures and crystals imperfections using ball models.
10. To study different composite materials.
11. To know the principle and working of Transmission Electron Microscope (TEM).
12. To know the principle and working of Scanning Electron Microscope (SEM).

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
CO5	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

General Course Information

Course Code: MEWP-204-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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, 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 and Mouthpieces: Classification of orifices and mouthpieces, Hydraulic coefficients, Discharge through a large rectangular orifice, Time of emptying a tank through an orifice, 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 ona 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. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi, 2010
5. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers, 1998
6. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill, 2009
7. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons, 2010
8. A text book of Fluid Mechanics and Hydraulic Machines-R. K. Rajput, S. Chand & Company, 2014
9. Fluid Mechanics and Hydraulic Machines-R. K. Bansal, Laxmi Publications, 2010
10. Fluid Mechanics and Machinery – S.K. Agarwal, TMH, New Delhi
11. Fluid Mechanics-Cengel and Cimbala, Mc Graw Hill Education, 2014
12. Fluid Mechanics White, F.M, Tata McGraw-Hill, 5th Edition, New Delhi, 2003.
13. 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: MEWP-204-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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 and open 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)

COMPUTER AIDED DESIGN

General Course Information

Course Code: MEWP-206-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to define Computer Aided Design (CAD), geometrical elements, modeling, and product design.	L1
CO2	Student will be able to discuss CAD, geometry features, modeling, and product features.	L2
CO3	Student will be able to demonstrate concepts related to CAD, geometrical elements, modeling, and product design.	L3
CO4	Student will be able to analyze CAD, geometrical elements, modeling, and product features.	L4
CO5	Student will be able to validate CAD, geometrical elements, modeling, and product features.	L5
CO6	Student will be able to reorganise CAD, geometrical elements, modeling and product features.	

Course Contents

UNIT-I

Introduction: Overview of CAD, History of CAD, Scope of CAD, Configurations for CAD workstations, CAD Softwares, File Standards, Types of Modeling – feature based, parametric, and form modeling, Types of Geometric Modeling.

Geometry: Coordinate System – origin, axes, and planes, Types of Views – orthographic, isometric, and perspective views, Introduction to Transformations, Transformation of Point and Line, 2D Transformations – translation, rotation, reflection, and scaling, 3D Transformations Translation– rotation, reflection, and scaling, Combined Transformations.

UNIT-II

Curves and surfaces: Curve Representation, Analytic Curves – lines, arcs, and circles, Synthetic Curves – Cubic, Bezier, b-spline, and non-uniform rational b-splines, Surface Representation, Analytic Surfaces – plane surfaces, ruled surfaces, surface of revolution, and tabulated cylinder, Synthetic Surfaces – bi cubic, Bezier, B-spline, and Coons patches.

Solids: Solid Primitive Models, Types of Representation – boundary representation, constructive solid geometry, sweeping, analytical solid modeling, and cell decomposition.

UNIT-III

2-D Modeling: CAD Sketching, Sketch Entities, Sketch Editing Tools – fillet, chamfer, trim, extend, break, offset, pattern, mirror, and constraints, Geometric Dimensioning and Tolerancing.

3-D Modeling: 3-D Modeling Tools – extrude, revolve, cut, sweep, loft, helix, hole, and thread, 3D Editing Tools – fillet, chamfer, draft, pattern, mirror, combine, and split, Assembly Modeling - assembly modeling, type of joints, and motion analysis.

UNIT-IV

Product Design: Product Life Cycle, Design thinking, Conceptual Design, Top-Down Approach, Bottom-Up Approach, Iterative Design.

Design for Engineering: Design for Manufacturing – machining, casting, welding, and additive manufacturing, Design for Assembly, Optimal Selection of Materials and Manufacturing Processes, Design for quality.

Text and Reference Books

1. Rao P.N. "CAD/CAM Principles and Applications" Eighth edition, 2013. Tata McGraw Hill India.
2. Zeid, I., "CAD/CAM", McGraw Hill, 2008.
3. Groover and Zimmer, "CAD/ CAM", Prantice Hall.
4. Krishnamoorathy, C. S. and Rajeev, J. S., "Computer Aided Design (Software and Analysis Tools)", Narosa Publication House, 2nd edition, 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	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
CO5	3	3	3	2	2	1	--	--	2	2	--	3	3	3	2
CO6	3	2	2	3	2	1	--	--	2	2	--	3	3	3	2

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

COMPUTER AIDED DESIGN LAB

General Course Information

Course Code: MEWP-206-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to reproduce drawings of mechanical components using CAD techniques.	L1
CO2	Students will be able to interpret CAD files and their corresponding drawings and models.	L2
CO3	Students will be able to examine sketches and models of mechanical components.	L3
CO4	Students will be able to explain mechanical parts using sketches and models.	L4
CO5	Students will be able to standardize CAD sketches and models.	L5
CO6	Students will be able to generate drawings and models of different components.	L6

Lab Contents

1. To import a 3D part into CAD software and export to different CAD files.
2. To prepare different views and representations of a 3D modeled part.
3. To create a sketch for a simple mechanical component.
4. To create a sketch for a simple mechanical component using proper dimensions and constraints.
5. To create a sketch of a complex mechanical component using proper dimensions and tolerances.
6. To create a 3D model of a mechanical part based on extrusion features.
7. To create a 3D model of a mechanical part based on revolve features.
8. To create a 3D model of a mechanical part based on sweep and loft features.
9. To create a 3D model of a mechanical part based on parametric design approach.
10. To create an assembly of simple rigid parts.
11. To create an assembly of moving components with proper constraints.
12. To create an engineering drawing of 3D modeled part.

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	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
CO5	3	3	3	2	2	1	--	--	2	2	--	3	3	3	2
CO6	3	2	2	3	2	1	--	--	2	2	--	3	3	3	2

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

MECHANICS OF SOLIDS-II

General Course Information

Course Code: MEWP-208-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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 carry out stress analysis of mechanical components by considering different failure criterions.	L4
CO5	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.	L5

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 andcompound 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 of uniform thickness, stresses in rotating discs of uniform strength, stresses in rotating cylinders.

Beam columns: Beam columns subjected to single concentrated load, number of concentrated loads, uniformly distributed load, 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, Castigliano's & Maxwell's theorems.

Springs: Open coiled helical spring subjected to axial loads and twisting couples using energy method for determining stresses and spring deflection, 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
CO5	3	2	3	2	2	--	--	--	1	1	2	3	3	3	1

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

MEASUREMENTS AND INSTRUMENTATION

General Course Information

Course Code: MEWP-210-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand fundamental elements, classification and standards of measuring instruments.	L1
CO2	Students will be able to identify and explain characteristics of instruments	L2
CO3	Students will be able to discuss transducers, intermediate, indicating and recording elements.	L3
CO4	Students will be able to describe the operation of transducers for strain, acceleration, pressure, temperature, and fluid flow measurement	L4
CO5	Students will be able to perform basic statistical analysis of experimental data	L5

Course Contents

UNIT-I

Instruments and Their Representation: Introduction, Typical Applications of Instrument Systems and Functional Elements of a Measurement System, Classification of Instruments, Standards and Calibration.

Characteristics of Instruments: Objective of studying the characteristics of the instruments. Static characteristics Accuracy, Precision, Resolution, Threshold, Sensitivity, Linearity, Hysteresis, Dead Band, Backlash, Drift. Errors: Classification of various types of errors and statistical analysis of experimental data.

UNIT-II

Transducer Elements: Introduction, Analog and Digital Transducers, Electromechanical; Potentiometric, Inductive Self Generating and Non-Self Generating Types, Electromagnetic, Electrodynamic, Eddy Current, Magnetostrictive, Variable Inductance, Linearly Variable Differential Transformer, Variable Capacitance, Piezo-Electric Transducer, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits, Single Double and Four Active Arm Bridge Arrangements, Temperature Compensation, Balancing and Calibration, Ionisation Transducers, Mechano-Electronic Transducers, Opto-Electrical Transducers, Photo Conductive Transducers, Photo Volatic Transducers, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer.

UNIT-III

Intermediate, Indicating and Recording Elements: Introduction, Amplifiers, Mechanical, Hydraulic, Pneumatic, Optical, Electrical Amplifying elements, Compensators, Differentiating and Integrating Elements, Filters, Classification

of Filters, A-D and D-A Converters, Digital Voltmeters (DVMs), Cathode Ray Oscilloscopes (CROs), Data Acquisition Systems, Data Display and Storage.

Motion, Force and Torque Measurement: Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass & Force Balance Type, Calibration, Hydraulic Load Cell, Pneumatic Load Cell, , Electro Mechanical Methods, Strain Gage, Torque Transducer, Toque Meter.

UNIT-IV

Pressure and Flow Measurement: Pressure & Flow Measurement, Introduction : Moderate Pressure Measurement, Monometers, Elastic Transducer, High Pressure Transducer, Low Pressure Measurement, Quantity Meters, Positive Displacement Meters, Flow Rate Meters, Variable Head Meters, Variable Area Meters, Rotameters, Pitot-Static Tube Meter, Drag Force Flow Meter, Turbine Flow Meter, Electro Magnetic Flow meter, Hot-Wire Anemometer.

Temperature Measurement: Introduction, Measurement of Temperature, Non Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials, Radiation Methods (Pyrometry), Total Radiation Pyrometer, Selective Radiation Pyrometer.

Text and Reference Books

1. Instrumentation, Measurement and Analysis – B.C. Nakra and K.K. Chaudhary, TMH.
2. Mechanical Measurements by D. S. Kumar, Kataria & Sons.
3. Measurements System Application and Design, E. O. Doeblin, 5th Ed., McGraw Hill, 2004.
4. Transducers in Mechanical and Electronic Design, L Trietly Harry., Dekker Marcel, Ist Ed., CRC Press, 1986.
5. Mechanical Measurements, T.G. Beckwith, R.D. Marangoni, and J.H. Lienhard, 6th Ed., Prentice Hall, 2006.

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
CO5	3	3	3	2	2	1	--	--	2	2	--	3	3	3	2

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

5th Semester

KINEMATICS OF MACHINES

General Course Information

Course Code: MEWP-301-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcomes	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 analyze 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

Mechanism and Machines: Elements or Links and their Classification- Rigid Link, Flexible Link and Fluid Link, Structure, Machine and Structure, Kinematic Pairs and their Types, Types of Constrained Motions, Kinematics Chain, Degree of Freedom, Machine and Mechanism, Kinematic Inversion, Inversions of Four Bar Kinematic Chain, Inversions of Single Slider Kinematic Chain, Inversions of Double Slider Kinematic Chain, Simple Problems

UNIT-II

Straight Line Motion Mechanism: Exact Straight Line Motion Mechanisms and their Types, Approximate Straight Line Motion Mechanisms and their Types, Straight Line Motions for Engine Indicators. Pantograph, Simple Problems

Steering Mechanism: Conditions for Correct Steering, Davis Steering Gear, Ackerman Steering Gear, Universal or Hooke's Joint, Single and Double Hooke's Joint, Simple Problems

UNIT-III

Velocity and Acceleration 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, 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

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

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.
5. R.S Khurmi, J.K. Gupta, Theory of Machines, S.Chand and Company Ltd., 2022

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: MEWP-301-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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

General Course Information

Course Code: MEWP-303-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the fundamentals of hydraulic machines and systems.	L1
CO2	Students will be able to understand various hydraulic machines and systems.	L2
CO3	Students will be able to apply the basics of fluid and power engineering to solve the problems related to hydraulic systems	L3
CO4	Students will be able to examine and compare the performance of given hydraulic machines or systems.	L4
CO5	Students will be able to evaluate the performance of hydraulic machines like turbines, pumps and systems.	L5
CO6	Students will be able to design and select a better hydraulic machine/system under given conditions.	L6

Course Contents

UNIT-I

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, numerical problems

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.

UNIT-II

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.

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, Working proportionsof a Francis turbine, Numerical Problems.

UNIT-III

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, Unit quantities: speed, discharge and power, Specific speed, Characteristic curves, Selection of turbines, Numerical problems.

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, Slip factor, Multistage pumps, Specific speed of centrifugal pumps, Performance characteristics of centrifugal pumps, Net positive suction head (NPSH), Cavitation in centrifugal pumps, Numerical problems.

UNIT-IV

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, Introduction to air vessels, Characteristic curves of a reciprocating pump, Numerical problems.

Hydraulic systems: Introduction, Hydraulic press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque converter.

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
CO5	3	3	2	3	2	2	3	1	1	2	1	1	3	2	3
CO6	3	3	3	3	3	3	3	2	1	3	1	2	3	2	3

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

HYDRAULIC MACHINES LAB

General Course Information

Course Code: MEWP-303-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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 apply the basic principles of hydraulic machines and can demonstrate its working.	L3
CO4	Students will be able to operate hydraulic machines and evaluate their performance.	L4
CO5	Students will be able to compare the performance of hydraulic machines and able to create characteristic curves at given conditions.	

Lab Contents

1. Evaluate and compare the theoretical and experimental results obtained on impact-jet apparatus for curved plate/vane at different conditions.
2. To determine the hydraulic power, mechanical power and efficiency of a Pelton turbine.
3. To draw the performance characteristics curves of Pelton turbine under different load conditions.
4. To determine the hydraulic power, mechanical power and efficiency of a Francis turbine.
5. To draw the constant head, constant speed and constant efficiency performance characteristics curves of a Francis turbine.
6. To study the construction details of a Kaplan turbine, its fluid flow circuit and characteristic curves.
7. To evaluate the performance of a Centrifugal Pump at different operating conditions.
8. To evaluate the performance 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 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	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
CO5	3	3	3	3	2	2	2	1	1	3	2	2	3	2	2

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

DESIGN OF MACHINE ELEMENTS

General Course Information

Course Code: MEWP-305-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to apply concepts of mechanics of materials to estimate the stresses in a machine element and predict failure of components based on theories of failure	L1
CO2	Students will be able to analyze the effect of fatigue load on machine elements and factors affecting it to predict failure.	L2
CO3	Students will be able to analyze and design the shafts, keys, cotter joint, knuckle joint and couplings.	L3
CO4	Students will be able to apply design knowledge for design of threaded fasteners, helical compression springs and spur gears.	L4
CO5	Students will be able to identify suitable lubricants for specific design applications and evaluate the bearing suitability based on design parameters.	L5

Course Contents

UNIT-I

Introduction to Design: Design Process, Factors Considered in Design, Selection of Materials, Use of Standards in Design, Direct Bending and Torsional Stresses in Machine Elements, Factor of Safety, Theories of Failures.

Design for Fatigue Strength: Stress Concentration, Theoretical Stress Concentration Factor, Size Factor, Surface Finish Factor, Fatigue Stress Concentration Factor, Notch Sensitivity, Variable and Cyclic Loads, Fatigue Strength, S-N Curve, Goodman's and Soderberg's relationship; Stresses due to combined loading.

UNIT-II

Design of Shafts: Torsion of shafts, design for strength and rigidity with steady loading, Design of shafts for combined bending, torsion and axial loads.

Design of Keys, Cotter Joint & Knuckle Joints: Keys: Types of keys, Design of keys, Design of Spigot and Socket cotter joint, Design of Knuckle Joint.

Couplings: Design of Flange Couplings, Bush and Pin type flexible coupling.

UNIT-III

Threaded fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static loading.

Design of Helical Compression Springs: Types of springs- stresses in Helical closed coil spring for circular cross sections.

UNIT-IV

Gears: Basic concepts and classifications of gears, design of spur gears

Lubrication and Bearings: Lubrication: purpose and requirement, Lubricant types, properties and selection, Classification of Bearings, bearing characteristic number and bearing modulus, coefficient of friction, minimum oil film thickness, Heat generated, Heat dissipated, Numerical problems on journal bearing design.

Text and Reference Books

1. Shiegly's Mechanical Engineering Design: Richard G Budynas and J Keith Nisbett, McGraw Hill Education, Special Indian Edition, 10th Edition 2014.
2. Design of Machine Elements: V. B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition 2017.
3. Machine Design, An Integrated Approach: Robert L. Norton, Pearson Education 4th Edition, 2010
4. Design of Machine Elements: M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. SI Contributions by A P Harsha, Pearson Education, 8th Edition, 2019.
5. Schaum's Outlines Machine Design: Allen S Hall, Alfred R Holowenko, Herman G Laughlin, Adapted by S. K. Somani, Tata McGraw Hill Education India, New Delhi, Special Indian Edition, 2008.
6. Design of Machine Elements -2: J. B. K. Das and P. L. Srinivasa Murthy, Sapna Book House, 2017.

Design Data Hand Books (Allowed for reference during Examination):

1. Machine Design Databook, Lingaiah K, 2nd Edition, Tata McGraw Hill Publishing, 2014
2. Design Data Hand Book, K. Mahadevan and K. Balaveera Reddy, CBS Publication, 4th Ed./4th Reprint, 2018

E-Books: Shigley's Mechanical Engineering Design [Kindle Edition], Richard Budynas, McGraw-Hill Higher Education; 10 edition, January 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	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
CO5	3	2	2	3	3	1	--	2	2	3	2	3	3	3	2

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

ENVIRONMENTAL SCIENCE

General Course Information

Course Code: MEWP-307-T Course Category: Mandatory Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to enhance and analyze human impacts on the environment.	L1
CO2	Students will be able to integrate concepts & methods from multiple discipline and apply to environmental problems.	L2
CO3	Students will be able to design and evaluate strategic terminologies and methods for subs table management of environmental systems.	L3
CO4	Students will be able to create knowledge on various local environment aspects which forms an irreplaceable tool in the entire learning process.	L4

Course Contents

UNIT-I

Multidisciplinary nature of Environmental studies: Definition, scope and importance, need for public awareness; Concept, Structure and function of an ecosystem: Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, Food webs and ecological pyramids; Introduction, types, characteristics features, structure and function of Forest ecosystem, Grassland ecosystem ,Desert ecosystem, Aquatic ecosystem (Ponds, Stream, lakes, rivers, oceans, estuaries); Biodiversity: Introduction, Definition: genetic, species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: consumptive use, productive use, social ethical, aesthetic and option values; Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-II

Renewable and non-renewable resources, Natural resources and associated problems, Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people; Water resources: Use and over utilization of surface and ground water, floods, droughts conflicts over water, dams benefits and problems; Mineral resources: Use and exploitation, environmental effects of extracting and mineral resources; Food resources: World food problem, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity; Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies; Land resources: Land as a resource,

land degradation, main induced landslides, soil erosion and desertification, Role of an individual in conservation of natural resources, Equitable use of resources for suitable lifestyle.

UNIT-III

Environment Pollution, Causes, effects and control measures: Air Pollution, Water Pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes effects and control measures of urban and industrial wastes; Role of and individual in prevention of pollution, Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, different laws related to environment: Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act; Issues involved in enforcement of environmental legislation, Public awareness.

UNIT-IV

Social issues and the Environment: From unsustainable to Sustainable development, Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problem and concern, case studies; Environment ethics: Issues and possible solutions; Wasteland reclamation; Consumerism and waste products; Human Population growth, variation among nation, Population explosion- Family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health.

Text and Reference Books

1. Fundamental concepts in Environmental studies by Dr. D.D. Mishra. S. Chand publications.
2. Essentials of Ecology and Environmental Science by Dr. S .V .S. Rana, PHI Learning Pvt. Ltd, Delhi
3. Environmental Chemistry by Anil Kumar De, Wiley Eastern Limited.
4. Environmental Science by T.G. Miller, Wadsworth Publishing Co, 13th edition.
5. Ecology and Environment by P. D. Sharma, Rastogi 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	1	1	2	1	1	1	3	1	1	1	2	3	3	3	1
CO2	1	1	2	2	2	1	3	1	1	1	2	3	3	3	1
CO3	1	1	2	1	1	1	3	1	1	1	2	3	3	3	1
CO4	1	1	2	2	2	1	3	1	1	1	2	3	3	3	1

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

Professional Elective -I

Course Code	Course Name	L	T	P	Credits
MEWP-309-T	Statistical Quality Control	3	-	-	3.0
MEWP-311-T	Production Management	3	-	-	3.0
MEWP-313-T	Operation Research	3	-	-	3.0

STATISTICAL QUALITY CONTROL

General Course Information

Course Code: MEWP-309-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the philosophy and core values of Statistical 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
CO5	Student will be able to apply sampling method to check the quality of a product lot.	L5

Course Contents

UNIT-I

Quality Control: Introduction, quality of design, quality of production, quality of conformance, quality of inspection, quality characteristics, quality and productivity, quality cost. Advantages of Statistical Quality Control in Industry.

Statistical concepts in Quality Control: Variation, variables and attribute. Frequency Distribution: Graphical representation. Statistical tools: Mean, median, mode, standard deviation, variance and dispersion, population and population combination. Normal distribution and frequency curves.

UNIT-II

Control Charts for Variables: Fundamentals of process control, tools of process control, Design and use of Control Charts for Variables: control limits, revision of control limits. Cause and effect diagram, inferences on the state of the process from control charts, Type I and Type II errors. Use of X (X bar) charts and R- charts, X (X bar) and σ- charts. Conclusions from control charts.

Control Charts for Attributes: Defects and defectives, advantages of attribute charts, control charts for fraction defectives (p-charts), control charts for number of defectives (np-charts), control charts for number of defects (C-charts), applications of attributes charts, comparison between variable charts and attribute charts.

UNIT-III

Acceptance Sampling: Introduction, advantages and limitations of sampling inspection, Industrial use of acceptance sampling, sampling methods. Operating characteristic curve (OC), Quality indices for acceptance sampling plans (AQL, RQL, IQL, AOQ), Average outgoing quality limit (AOQL).

Sampling Plans: Types of Standard Sampling Plans, design of sequential sampling plans, characteristics of a good acceptance plan, comparison between single, double and multiple sampling plans.

UNIT-IV

Reliability: Definition, Quality control and reliability, elements of reliability, methods for improving reliability, reliability tests, measurement of reliability, designing for reliability, quality and reliability.

6σ Quality approach: Six sigma quality approach, mathematical concept of six sigma, practical approach to six sigma quality, TQM and 6σ, six sigma and Indian industries.

Text and Reference Books

1. Statistical Quality Control – By Mahajan M, Dhanpat Rai & Co
2. Quality control Application – By Hansen BL, Ghare PH; Prentice Hall of India.
3. Statistical Quality Control – By E.L. Grant & R.S. Levenworth; T MH.
4. Quality Control – Paranthaman, D.; Tata McGraw Hill, India
5. Quality Planning and Analysis – Juran J.M. and F.M. Gryna, TMH, India
6. Total Quality Control – By Feigenbaum, A.V.; McGraw Hill International.
7. 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
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)

PRODUCTION MANAGEMENT

General Course Information

Course Code: MEWP-311-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define proper use of industrial resources.	L1
CO2	Students will be able to describe various aspect of production management.	L2
CO3	Students will be able to apply the knowledge of various quality techniques.	L3
CO4	Students will be able to analyze industrial planning and management.	L4
CO5	Students will be able to evaluate production management system of an industry.	L5

Course Contents

UNIT-I

Introduction to Production Management- Introduction, History of Production Management, Definitions ofProduction 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 utilization.

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, 2nd edition, 2006.
2. Buffa & Sarin, "Modern Production Management", John Wiley Publication, 8th edition, 2007
3. Prof. K.C. Jain, "Production and Operations Management", Wiley, 2013.
4. M.Mahajan., "Statistical Quality Control", Dhanpat Rai Publication. 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	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)

OPERATION RESEARCH

General Course Information

Course Code: MEWP-313-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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)

6th Semester

FUNDAMENTAL OF MANAGEMENT

General Course Information

Course Code: MEWP-302-T Course Category: Humanities and Social Sciences including Management Courses Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to define fundamental concepts of management.	L1
CO2	Students will be able to explain the basic principles of management related to planning and decision making	L2
CO3	Students will be able to apply the managerial skills to solve real world management problems.	L3
CO4	Students will be able to identify leadership roles in various scenarios.	L4
CO5	Students will be able to evaluate a business model based on principles of management.	L5

Course Contents

UNIT-I

Management: Definition, Scope and process of management, Managerial Roles, Levels of Management, Managerial skills, Challenges of Management, Evolution of Management, Scientific and Administrative management, The Behavioural Approach, The Quantitative Approach, The System Approach, Contingency Approach, IT Approach.

UNIT-II

Planning and Decision Making: General framework for planning, Planning process, Types of plans, Management by objectives, Development of business strategy.

Decision making and Problem Solving: Programmed and Non-Programmed Decisions, Steps in Problem solving and Decision making, Bounded Rationally and Influences on Decision making, Group problem solving and decision making, Creativity and Innovation in Managerial work.

UNIT-III

Organization HRM and Controls: Organizational Design and Organizational structurers, Delegation Empowerment, Centralization, Decentralization, Organizational culture, Organizational climate and Organizational change, Talent management, Talent management models and strategic human resource planning, Recruitment and selection, Training and development, Performance and Appraisal, Types of control and controlling Techniques.

UNIT-IV

Leading and Motivation: Leadership, Power and Authority, Leadership Styles, Behavioural leadersip, Situational leadership, Leadership skills, Leader as mentor and coach, Leadership during adversity and crisis, Handling employees and customer complaints, Team leadership. Motivation: Types of motivation, Relationship between motivation, performance and engagement, Content motivational theories.

Text and Reference Books

1. Robert N Lussier, Management Fundamentals, 5th edition, Cengage Learning, 2013.
2. Stephen P. Robbins, Fundamentals of Management, Pearson Education, 2009.
3. Weihrich Koontz, Essentials of Management, fifth edition, Tata McGraw Hill, 1990.
4. Dubrin Andrew, Management Essential, 9th edition, Cengage Learning, 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	1	--	1	1	1	2	--	1	3	3	1	2	3	3	1
CO2	1	--	1	1	1	2	--	1	3	3	1	2	3	3	1
CO3	1	--	1	1	1	2	--	1	3	3	1	3	3	3	1
CO4	--	--	1	1	1	2	--	1	3	3	1	3	3	3	1
CO5	2	3	2	2	1	2	1	1	2	3	1	3	3	3	2

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

DYNAMICS OF MACHINES

General Course Information

Course Code: MEWP-304-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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

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-II

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-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.
5. R.S Khurmi, J.K. Gupta, Theory of Machines, S.Chand and Company Ltd., 2022

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: MEWP-304-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment 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, 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)

COMPUTER AIDED MANUFACTURING

General Course Information

Course Code: MEWP-306-T Course Category: Professional Core Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Duration: 3 hours	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe Computer Aided Manufacturing (CAM), Computer Control Machines (CNC), Programming and additive manufacturing.	L1
CO2	Students will be able to explain CAM, Computer Control Machines (CNC), Programming and additive manufacturing.	L2
CO3	Students will be able to illustrate CAM, Computer Control Machines (CNC), Programming and additive manufacturing.	L3
CO4	Students will be able to analyze CAM, Computer Control Machines (CNC), Programming and additive manufacturing.	L4
CO5	Students will be able to validate CAM, Computer Control Machines (CNC), Programming and additive manufacturing.	L5
CO6	Students will be able to design CAM, Computer Control Machines (CNC), Programming and additive manufacturing.	L6

Course Contents

UNIT-I

Introduction to CAM: Definition and importance of CAM, History and evolution of CAM technologies. Types of CAM systems, Benefits and challenges of CAM, Overview of popular CAM software's.

Integration of CAD and CAM: Overview of CAD/CAM integration, Benefits, and challenges of integrating CAD and CAM systems, File formats for CAD/CAM data exchange, Automating the CAM process using CAD models.

UNIT-II

Fundamentals of CNC Machines: Types of CNC machines (Milling, Turning, Wire cut EDM) and their applications. Components and functions of CNC machines, Understanding coordinate systems, Machine axes and their movements.

CNC Programming Basics: Components of part program, Steps in CNC programming, Program Reference Zero, G-Codes, Miscellaneous functions, Absolute and Incremental systems. Geometric Calculations.

UNIT-III

Manual part programming: CNC Tooling, Tool Radius and Length Compensation, writing basic CNC programs for Turning and Milling Machine Tool, Canned Cycles, Cut Planning, Thread Cutting.

Advanced CNC Programming: Creating and using subprograms, Implementing macros for repetitive tasks, Programming techniques multi axis CNC machines, Emerging technologies in CNC machining, The future of CNC programming and smart manufacturing.

UNIT-IV

CAM Programming: Overview of CAM, toolpath generation, part setup – work model, stock, coordinate system, zero position, type of CAM processes for machining, CAM processes for turning, post-processing for machine codes.

Automatically Programmed Tool (APT) language: Definition and importance of APT, Understanding the syntax and structure of APT programs, Writing simple APT programs, Motion Commands and Tool Path Generation, Post Processor Statements, Auxiliary Statements.

Text and Reference Books

1. Rao P.N. "CAD/CAM Principles and Applications" Eighth edition, 2013.
2. Jon S. Stenerson, Kelly Curran, "Computer Numerical Control: Operation and Programming", Prentice Hall, 3rd edition 2007.
3. Mattson Mike, "CNC Programming: Principles & Applications", Cengage learning, 1st edition 2013.
4. Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Higher Education, 3rd edition 2013.
5. Michael J. Peterson, "CNC Programming: Basics & Tutorial Textbook", Create Space Independent Publishing Platform, 1st edition 2008.
6. 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	3	--	--	--	2	1	--	3	3	3	3
CO2	3	3	3	1	3	--	--	--	2	2	--	3	3	3	3
CO3	3	3	3	1	3	--	--	--	2	1	--	3	3	3	3
CO4	3	3	3	1	3	--	--	--	2	2	--	3	3	3	3
CO5	3	3	3	2	3	--	--	--	2	3	--	3	3	3	3
CO6	3	3	3	2	3	--	--	--	2	3	--	3	3	3	3

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

COMPUTER AIDED MANUFACTURING LAB

General Course Information

Course Code: MEWP-306-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to reproduce settings and programs of CNC machines and 3D printer.	L1
CO2	Students will be able to interpret part programs and commands of CAM machines.	L2
CO3	Students will be able to examine models and programs prepared on CNC machines and 3D printer.	L3
CO4	Students will be able to explain CAM machines.	L4
CO5	Students will be able to standardize programs of CAM machines.	L5
CO6	Students will be able to generate programs and commands of CNC machines and 3D printer.	L6

Lab Contents

1. To import a 3D model of mechanical part into CAM software from CAD software.
2. To perform component identification and work setting of CNC turning center.
3. To perform component identification and work setting of CNC machining center.
4. To perform component identification and work setting of CNC wire-EDM.
5. To perform component identification and initialization of 3D printer.
6. To understand part programming codes and their syntax in CNC turning center, machining center, and wire-EDM.
7. To prepare a part program for CNC turning center.
8. To prepare a part program for CNC machining center.
9. To prepare a part program for CNC wire-EDM.
10. To prepare a part program for CNC turning center using CAM software (CamConcept, Autodesk Fusion 360, Master CAM, etc.).
11. To prepare a part program for CNC machining center using CAM software (CamConcept, Autodesk Fusion 360, Master CAM, etc.).
12. To prepare a part program for CNC wire EDM using CAM software (Elcam etc.).
13. To prepare machine command for 3D printer using CAM software (Cura, etc.).

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	1	1	3	--	--	--	2	1	--	3	3	3	3
CO2	3	3	3	1	3	--	--	--	2	2	--	3	3	3	3
CO3	3	3	3	1	3	--	--	--	2	1	--	3	3	3	3
CO4	3	3	3	1	3	--	--	--	2	2	--	3	3	3	3
CO5	3	3	3	2	3	--	--	--	2	3	--	3	3	3	3
CO6	3	3	3	2	3	--	--	--	2	3	--	3	3	3	3

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

HEAT TRANSFER

General Course Information

Course Code: MEWP-308-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 4; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods** **Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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

Heat Conduction Equation: Definition of Heat Transfer, Modes of heat flow, Thermal conductivity, Combined heat transfer system, Conduction equation in Cartesian, polar and spherical co-ordinate systems.

Steady State Heat Conduction: Introduction, I-D heat conduction through a plane wall, long hollow cylinder, hollow sphere, Numericals.

UNIT-II

Extended surfaces (Fins): Introduction, 1-D heat conduction with heat sources, Extended surfaces (fins), Fin effectiveness, Numericals.

Transient Heat Conduction: Introduction, systems with negligible internal resistance (lumped parameter analysis), time constant and response of temperature measuring instruments, Numericals.

UNIT-III

Convection: Forced convection-Thermal and hydro-dynamic boundary layers, energy equation, 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, 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.

UNIT-IV

Thermal Radiation: The Stephen-Boltzmann law, black body radiation, Shape factors and their relationships, Heat exchange between non black bodies, Radiation shields, Numericals.

Heat Exchangers: Classification, Performance variables, Analysis of a parallel/counter flow heat exchanger, Heat exchanger effectiveness, 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: MEWP-308-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment 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

Lab Contents

1. To find out total thermal resistance and total thermal conductivity of a composite slab.
2. Evaluate the heat transfer coefficient, Nusselt number and heat transfer rate from vertical cylinder under natural convection mode.
3. To determine the value of Stefan Boltzmann constant for radiation heat transfer.
4. To find out the emissivity of gray surface (or gray body) from the given test rig.
5. To determine the thermal conductivity of the given metallic rod.
6. To evaluate the convective heat transfer coefficient, Nusselt number and rate of heat transfer by forced convection for flow of air inside a horizontal pipe.
7. To determine the thermal conductivity of insulating powder filled in spherical copper container at various heat inputs.
8. To determine the value of heat transfer co-efficient under forced condition and to find (a) theoretical values of temperatures along the length of fin (b) effectiveness and efficiency of the pin-fin for insulated and boundary condition.
9. To determine the thermal conductivity of a poor conducting material (asbestos sheet) by 'guarded hot plate method'.
10. To determine LMTD, effectiveness and overall heat transfer coefficient for parallel and counter flow heat exchanger.
11. To study the heat pipe demonstrator.
12. To study the two phases heat transfer unit.

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)

Professional Elective -II

Course Code	Course Name	L	T	P	Credits
MEWP-310-T	Automation in Manufacturing	3	-	-	3.0
MEWP-312-T	Modern Machining Processes	3	-	-	3.0
MEWP-314-T	Reverse Engineering	3	-	-	3.0
MEWP-316-T	Micro and Nano Manufacturing	3	-	-	3.0

AUTOMATION IN MANUFACTURING

General Course Information

Course Code: MEWP-310-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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
CO5	Students will be able to analyze the performance of automation system.	L5

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
CO5	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1

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

MODERN MACHINING PROCESSES

General Course Information

Course Code: MEWP-312-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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
CO5	Students will be able to compare different non-traditional machining processes on the basis of power consumption and material removal rate.	L5

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
CO5	3	--	2	--	--	2	2	3	2	2	2	3	3	2	2

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

REVERSE ENGINEERING

General Course Information

Course Code: MEWP-314-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

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
CO5	Students will be able to create a virtual and physical prototype based on reverse engineering Technology	L5

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, photogrammetric reconstruction.

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 Rapidprototyping 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.
6. Martin Weinmann, Reconstruction and Analysis of 3D Scenes, Springer International Publishing, 2016, ISBN: 978-3-319-29244-1

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
CO5	3	3	3	3	3	2	2	--	2	2	--	3	3	3	3

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

MICRO AND NANO MANUFACTURING

General Course Information

Course Code: MEWP-316-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 Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks **End semester examination (70 marks):** • 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. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to Understand the synthesis and processing at micro and nano scale	L1
CO2	Students will be able to Describe the micro-manufacturing techniques and related instrumentation.	L2
CO3	Students will be able to Discuss the nanofabrication techniques and nanomaterials	L3
CO4	Students will be able to Distinguish between various non-conventional micro-nano manufacturing processes.	L4
CO5	Students will be able to Classify methods for surface and structural characterization of materials.	L5

Course Contents

UNIT-I

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, challenges in Nanotechnology. Nano materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation (CVC)- Cold Plasma Methods.

UNIT-II

Micro- and nano manufacturing Techniques: Introduction to micromachining, Micro drilling – process, tools and applications Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications Micro milling and Micro grinding – process, tools and applications Micro extrusion- process and applications Nano-Plastic forming, Laser technology in micro manufacturing, application of technology fundamentals, Surface Micromachining, Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications

UNIT-III

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Spectroscopic characterizations: Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy

UNIT-IV

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). Thermal Characterization of Nanomaterials: DTA, TGA, DSC (Principle and Applications).

Text and Reference Books

1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press.
2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press.
3. V.K.Jain, Micro-manufacturing Processes, CRC Press,
4. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer.
5. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York.
6. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice 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
CO5	3	--	2	--	--	2	2	3	2	2	2	3	3	2	2

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