GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

An Autonomous Institute

'A' GRADE ACCREDITED BY NAAC

Evaluation Scheme & Syllabus For

Master of Technology (Machine Design) 1st Year

(Effective from the Session: 2025-26)

APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU, ROHTAK

1. DEFINITION OF CREDIT

1	1 Lecture (L) per week	1 Credit
2	2 Practical (Lab) per week	1 Credit
3	2 Seminar per Week	2 Credit
4	4 Project per Week	2 Credit

2. RANGE OF CREDIT

A credits of 86 for a student to be eligible to get Post Graduate degree in Machine Design.

3. STRUCTURE OF POSTGRADUATE ENGINEERING PROGRAM (M. TECH)

Sr. No.	Category	Breakup of Credits
1	Professional Core Courses	32
2	Professional Elective Courses	8
3	Multidisciplinary Open Elective Courses	6
4	Foundation Elective Courses	3
5	Mandatory Learning Course	3
6	Seminar	6
7	Lab Courses	4
8	Project	2
9	Dissertation	22
	Total Credits	86

4. COURSE CODE AND DEFINITIONS

Sr. No.	Category	Course Code
1	Professional Core Courses	PCC
2	Professional Elective Courses	PEC
3	Multidisciplinary Open Elective Courses	OEC
4	Foundation Elective Courses	FEC
5	Mandatory Learning Course	MLC
6	Seminar	SM
7	Lab Courses	LC
8	Project	PROJ
9	Dissertation	DISS

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examination

M.Tech (MACHINE DESIGN) – 1st Semester

w.e.f. 2025-26

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Courses	PCC-MTMD-101A	Numerical Analysis and Optimization	4	0	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-MTMD-103A	Instrumentation and Measurement	4	0	0	4	4	40	60		100	3
3	Professional Core Courses	PCC-MTMD-105A	Experimental Stress Analysis	4	0	0	4	4	40	60		100	3
4	Professional Core Courses	PCC-MTME-107A	Metal Forming Analysis	4	0	0	4	4	40	60		100	3
5	Professional Core Courses	PCC-MTME-109A	Mechatronics and Product Design	4	0	0	4	4	40	60		100	3
6	Lab Course	LC-MTMD-111A	Experimental Stress Analysis Lab	0	0	2	2	1	25		25	50	3
7	Lab Course	LC-MTMD-113A	Mechanical Measurement Lab	0	0	2	2	1	25		25	50	3
8	Seminar-I	SM-MTMD-115A	……	0	0	2	2	2	50			50	
Total Credits								**24**				**650**	

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examination

M.Tech (MACHINE DESIGN) – 2nd Semester

w.e.f. 2025-26

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Courses	PCC-MTMD-102A	Theory of Elasticity	4	0	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-MTMD-104A	Design of Mechanisms	4	0	0	4	4	40	60		100	3
4	Professional Elective Courses	Refer Table -I	……	4	0	0	4	4	40	60		100	3
5	Multidisciplinary Open Elective Courses	Refer Table -II	……	3	0	0	4	3	40	60		100	3
6	Foundation Elective Courses	Refer Table -III	……	3	0	0	4	3	40	60		100	3
7	Lab Course	LC-MTMD-106A	Material Testing Lab	0	0	2	2	1	25		25	50	3
8	Lab Course	LC-MTMD-108A	Design Practice Lab – I	0	0	2	2	1	25		25	50	3
9	Seminar-II	SM-MTMD-110A	……	0	0	2	2	2	50			50	
Total Credits								**22**				**650**	

Table I (Program Elective Courses)

Course Code	Course Title
PEC-MTMD-112A	Computer Aided Design
PEC-MTMD-114A	Design of Pressure Vessels
PEC-MTME-116A	Materials Management
PEC-MTME-118A	Finite Element Method

Table II (Multidisciplinary Open Elective-I Courses)

Students of all M. Tech programmes are required to study one multidisciplinary open elective course and one foundation elective course in 2nd Semester for 2-Years Programmes. They may choose any one of the following courses (excluding the courses offered by the departments of their own subjects, if not stated otherwise).

SN	Courses Code	Course Title	Offered by Department
1	OEC-130A	Basic of Economics	Management Department
2	OEC-132A	Fundamental of Management	Management Department
3	OEC-134A	Disaster Management	Civil Engineering
4	OEC-136A	Industrial Safety	Fire Technology and Safety
5	OEC-138A	Indian Literature in Translation-I	Applied Sc. & Humanities (English)
6	OEC-140A	Environmental Issues	Applied Sc. & Humanities (Chemistry)
7	OEC-142A	Quantitative Techniques	Applied Sc. & Humanities (Mathematics)
8	OEC-144A	Sources of Energy-I	Electrical Engineering
9	OEC-146A	Operation Research	Mechanical Engineering
10	OEC-148A	Multimedia Communication	Electronics and Communication Engineering
11	OEC-150A	Introduction to Information Technology	Computer Sc. & Applications
12	OEC-152A	Cyber Forensics and Security	Computer Sc. & Engineering
13	OEC-154A	Computer Science and Principles	Computer Sc. & Engineering
14	OEC-156A	Software Engineering Practice	Computer Sc. & Engineering

Table III (Foundation Elective Courses)

SN	Courses Code	Course Title	Offered by Department
1	FEC-158A	Basics of Accounting	Management Department
2	FEC-160A	Basics of E-commerce	Management Department
3	FEC-162A	Element of Banking	Management Department
4	FEC-164A	Computer Fundamentals	Computer Science and Engineering
5	FEC-166A	Communication and Soft Skills	Applied Science and Humanities (English)
6	FEC-168A	Entrepreneurship Development	Management Department
7	FEC-170A	Electronics Engineering	Electronics and Communication Engineering

Course Code	**PCC-MTMD-101A**				
Category	Professional Core Courses				
Course Title	**Numerical Analysis and Optimization**				
Scheme and Credits	L	T	P	Credits	**Semester-I**
	4	0	0	4	
Course Objectives	The objectives of this course are • Provide knowledge to approximate solutions for complex equations, where exact solutions are either impossible or impractical to find. • Study and minimize errors in numerical calculations, ensuring that algorithms are reliable, accurate, and stable across various computational environments. • Learn algorithms that optimize computational resources, making them suitable for large-scale problems and real-time applications. • Find maximum or minimum values in complex systems, which are essential for areas like engineering, machine learning, economics, and physics. • Develop skills to apply numerical and optimization techniques to solve practical problems in engineering, data science, finance, and various scientific disciplines where traditional analytical solutions are insufficient.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define basics and terminologies of numerical analysis and optimization.
CO2	Explain the concepts of numerical methods, approximation, optimization and programming etc.
CO3	Solve the problems by using various numerical methods or techniques.
CO4	Analyze the problem related to optimization, approximation, programming etc.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**System of linear algebraic equations and Eigen value problems**: elimination method, Gauss method, Gauss-Jordan method; Eigen values and Eigen vectors, bounds on Eigen values, Jacobi methods for symmetric matrices, householder's method for symmetric matrices. **Interpolation and approximation**: interpolation problem, linear interpolation, Lagrange interpolation, Newton interpolation, interpolation with equidistant points, spline interpolation, least square approximation.
Unit-II	**Numerical differentiation and integration**: differentiation of continuous functions, forward difference quotient, central difference quotient, error analysis; derivatives from differences table, higher-order derivatives, Richardson extrapolation techniques, Newton-Cotes method, trapezoidal rule, Simpson's rule, higher order rules, Romberg integration. **Numerical solution of ordinary differential equations**: Taylor's series method, Euler and modified Euler method, Runge-Kutta methods, Milne's method, Adam-Bashforth-Moulton method.
Unit-III	**Optimization**: basic concept of optimization, classification of optimization, optimization techniques, engineering applications of optimization. Classical optimization techniques: unconstrained optimization single-variable optimization, multivariable optimization, multivariable optimization, multivariable optimization with equality constraints: solution by direct search method, solution by Lagrange-multipliers method, multivariable optimization with inequality constraints, Kuhn-Tucker conditions. **Non-linear optimization**: general non-linear programming problem, classification of non-linear programming problem, unconstrained optimization techniques: direct search method, gradient method. Constrained optimization techniques: separable programming, quadratic programming.
Unit-IV	**Dynamic programming**: Multistage decision process: representation of a multistage decision process, conversion of nonserial system to a serial system, types of multistage decision problems, principle of optimality, computational procedure in dynamic programming, linear programming as a case of dynamic programming, application of dynamic programming.

Suggested Readings

1. Engineering Optimization, by SS Rao; New Age International Ltd.
2. Numerical Method, by E. Balagurusamy; Tata McGraw Hill.
3. Numerical methods for Scientific & Engineering Computation, by MK Jain, SRK Iyengar and RK Jain; New Age International Ltd.

Useful Video links

	Topic	Link
UNIT-I	System of linear algebraic equations and Eigen value problems	https://www.youtube.com/watch?v=IfmOZoqoW3I
		https://www.youtube.com/watch?v=6Zacf25sXhk
	Interpolation and approximation	https://www.youtube.com/watch?v=Lp2MdAvk2MY
		https://www.youtube.com/watch?v=nhfCY43iAP0
UNIT-II	Numerical differentiation and integration	https://nptel.ac.in/courses/111106101
	Numerical solution of ordinary differential equations	https://nptel.ac.in/courses/111105038
UNIT-III	Optimization	https://nptel.ac.in/courses/111105039
	Non-linear optimization	https://nptel.ac.in/courses/111105039
UNIT-IV	Dynamic programming	https://nptel.ac.in/courses/111107104

Course Code	**PCC-MTMD-103A**				
Category	Professional Core Courses				
Course Title	**Instrumentation and Measurement**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Comprehensive understanding of the basic principles of instrumentation and measurement. • Learn various measurement techniques to select appropriate instruments for specific measurement tasks. • Develop skills in using appropriate instruments to measure displacement, force, torque, power, temperature, pressure, and flow. • Provide knowledge of statistical methods to analyze data accuracy, calculate mean, variance, and understand error sources. • Facilitate instrumentation concepts to real-world applications such as power plant systems, air conditioning controls, and industrial robotics.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the terms and concepts of instrumental and measurement.
CO2	Explain the working of various measurements & instrumentation devices.
CO3	Use suitable instruments for the measurement of errors and different parameters.
CO4	Analyze the various parameters such as force, power, temperature, pressure and flow.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Introduction to Instrumentation:** Major elements of a measurement system. Order, type of signals, response of instruments. Importance of sensors in measuring system. Errors and response characteristics of sensors. Measurement error. **Measurement Techniques Signal conditioning:** Amplification and noise filtering, impedance matching, Wheatstone Bridge technique. Digital signal processing: Sampling rate, aliasing, discretization, A/D and D/A converters, frequency content of a signal, concept of FFT. Common measuring instrument: Multimeter, oscilloscope, spectrum analyzer, display and recorder, plotter. Statistical analysis of data: Concept of normal distribution, mean and variance (standard deviation).

Unit-II	**Displacement and Motion Measurement:** Potentiometer, linear variable differential transformer, strain gauge, proximity probe. Angular velocity measurement: Mechanical and electric tachometer. Seismic instrument: Accelerometer. **Force, Torque & Power Measurement:** Force measurement: elastic force transducer, piezoelectric force transducer, hydraulic and pneumatic method. Torque measurement: Using shaft deflection, using induced strain, torque reaction method. Power measurement: Absorption dynamometer, mechanical & hydraulic method, transmission dynamometer, torque mete
Unit-III	**Temperature Measurement:** Thermal expansion method: Liquid-in-glass thermometer, pressure thermometer, bimetal type thermometer. Resistance Thermometer: RTD, thermistor. Thermocouple, quartz thermometer, radiation thermometer. **Pressure Measurement:** Measuring static pressure: Piezometer, manometer. Measuring dynamic & static pressure: Pressure transducer, bellow-type, diaphragm-type, piezoelectric. Bourdon tube pressure gauge.
Unit-IV	**Flow Measurement:** Obstruction meter: Venturi meter, nozzle, orifice meter, pitot tube. Positive displacement flowmeter: Rotary-vane meter, rotameter. Special methods: Turbine flow meter, ultrasonic flowmeter, magnetic flowmeter, hot wire anemometer, open channel flowmeter, laser Doppler flowmeter. Examples of Instrumentation Boiler power plant instrumentation, air conditioning plant control, industrial robotics system, etc.

Suggested Readings

1. Instrumentation and Measurement, by Nakra & Choudhry.
2. Instrumentation for Engineering Measurements, by JW Dally; John Wiley & Sons.
3. Experimental Methods for Engineers, by JP Holman; McGraw Hill.
4. Mechanical Measurements, by Thomas Beckwith and Lewis Buck; Narosa Publishing House.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Mechanical Measurement System	https://onlinecourses.nptel.ac.in/noc22_me08/preview
	Analog-to-Digital Converter	https://www.youtube.com/watch?app=desktop&v=TirvWsbqBUc
UNIT-II	Linear Variable Differential Transformer or Transducer Working	https://www.youtube.com/watch?v=E-kDsP0wq6w
	Sensors & Transducers	https://youtu.be/zxYeJW9v6OU?si=YSfjQEDyD9q2OUPL
UNIT-III	Thermal Expansion	https://www.youtube.com/watch?v=Lzrjqy4PImE
	Pressure Measurement using Piezometer	https://www.youtube.com/watch?v=uEMghhfXuoA
	Pressure Measurement	https://www.youtube.com/watch?v=sHmjE21Fp9w
UNIT-IV	Flow rate measurement	https://www.youtube.com/watch?v=bsR3o-cFyMU

Course Code	**PCC-MTMD-105A**				
Category	Professional Core Courses				
Course Title	**Experimental Stress Analysis**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Provide foundational knowledge of stress, strain, and material behavior under various loads. • Learn and apply key experimental methods, such as strain gauges and photo elasticity, for stress analysis. • Gain skills to accurately interpret experimental data and assess measurement uncertainties. • Acquire hands-on experience in setting up experiments to analyze stress distributions in materials. • Develop the ability to validate theoretical models through experimental findings.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the terminologies related to experimental stress analysis.
CO2	Explain the fundamental principles of stress and strain analysis and their application to experimental techniques.
CO3	Use appropriate experimental method and circuit to measure stress and strain in components.
CO4	Analyze the stress-strain behavior of materials under various loading conditions using experimental techniques.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Strain Measurement:** An ideal strain gauge, mechanical, optical, acoustical, pneumatic, dielectric and electrical strain gauges. Differential transformer and piezoelectric transducers. **Electrical Wire Resistance Strain Gauges:** bonded type gauges, bonding agents, foil gauges, gauge materials. Weldable gauges. Strain gauge adhesive. Fixing of gauges. Temperature effects in bonded gauges. Gauge factor and gauge sensitivity. Measurement of stress and stress gauge.
Unit-II	**Measuring Circuits and Strain Gauge Rosette:** Potentiometer circuit, Wheatstone bridge, circuit sensitivity and output, temperature compensation and signal addition. Rectangular, delta and tee-delta rosette. Application of strain gauge in practical problems.

Unit-III	**Whole Field Methods:** Photo elasticity, stress loci, isoclinic, isostatics and isochromatic, stress optic law and strain optic law, photo elastic materials, polarization of light, plane polarized and elliptically polarized light. Brittle coating, crack pattern and crack detection in coating. Moire Fringe, geometry.
Unit-IV	**Analysis** of Photo Elasticity Data, polariscope, fringes due to principal stress direction and difference, model making, interpretation of isoclinic and isochromatic and fractional fringe order. Calibration through tension, beam and disc models. Reflection polariscopic. Application to stress concentration and stress intensity factor. Separation of stresses.

Suggested Readings

1. Experimental Stress Analysis, by Abdul Mubeen; Dhanpat Rai and Sons.
2. Experimental Stress Analysis, by JW Dally and WF Riley; McGraw-Hill.
3 The Strain Gage Primer, by CC Perry and HR Lissner; McGraw-Hill.
4. Moire Fringes in Strain Analysis, by PS Theocharis; Pergamon Press.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Overview on strain gauges	http://acl.digimat.in/nptel/courses/video/112106198/L12.html
	Differential transformer and piezoelectric transducers	https://www.youtube.com/watch?v=DifpQoX-1-k
	Weldable Strain Gage Installation	https://www.youtube.com/watch?v=QWz3aBRkHIY
UNIT-II	Sensitivity of Wheatstone bridge Circuit in Strain Gauge.	https://www.youtube.com/watch?v=bIzArJ0SJrE
	Strain Rosette	https://www.youtube.com/watch?v=E517Zp6QysE
	Application of strain gauge in practical problems	https://www.youtube.com/watch?v=PCSweA7Idz0
UNIT-III	Stress analysis using photo elasticity	https://www.youtube.com/watch?v=mhtp6PhT4aU
	Fringe Ordering in Photo elasticity	https://www.youtube.com/watch?v=4tmYHvpPQrg
	Moire Fringe	https://www.youtube.com/watch?v=MuYsFPuiadc
UNIT-IV	Fracture Mechanics (Crack Resistance, Stress Intensity Factor)	https://www.youtube.com/watch?v=rKi6_ibjVPA
	Different Polariscope	https://www.youtube.com/watch?v=ZFG0bNi1J-Y
	Stress concentration and stress intensity factor	https://www.youtube.com/watch?v=Th7oieAjpNg

Course Code	**PCC-MTME-107A**				
Category	Professional Core Courses				
Course Title	**Metal Forming Analysis**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Comprehensive understanding of principles of elastic and plastic deformation in materials and their application to metal forming processes. • Learn the yield criteria and plasticity theory, including their application in analyzing metal forming processes like forging, rolling, extrusion, and sheet metal forming. • Enable to understand the role of lubrication and friction in metal forming processes, including the selection of lubricants for different applications. • Facilitate the application of finite element methods (FEM) for simulating and optimizing metal forming processes.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated
CO1	Define the technical terms used in metal forming analysis.
CO2	Explain the fundamental principles of metal forming processes, including deformation mechanics, material flow, lubrication and stress-strain relationships.
CO3	Apply the knowledge of metal forming analysis to solve the complex engineering problem.
CO4	Analyse the different processes, mechanism used in metal forming analysis.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Stress-Strain relations in Elastic and plastic Deformations**: True stress and true strain, true stress-strain curves, selection of stress-strain curves for cold and hot working, yield of isotropic plastic material, yield criteria. Tresca maximum sheer-strain- energy criterion, plastic incompressibility, Poisson's ratio for plastic deformation flow rule, application of theory of plasticity for solving metal forming Problems using Slab method, Upper and lower Bound methods, Slip line field theory.

Unit-II	**Technology and analysis of important metal forming processes:** Forging, Rolling, Extrusion. Wiredrawing, Sheet Metal forming processes like Deep drawing, Stretch forming, bending, defects in various metal forming processes like rolling, forging, extrusion, wiredrawing and deep drawing and their causes and remedial measures, Effects of temperature and strain rate in metal working, friction and lubrication in Hot and Cold working.
Unit-III	**Lubrication in metal forming processes**: principles and mechanism of lubrications, hydrodynamic and their film lubrication, boundary and extreme pressure lubricants, solid lubricants, lubricants used for rolling and cold drawing, forging.
Unit-IV	**Application of Finite Element Methods to Metal Forming Processes:** special Discretization, Shape function, Stiffness matrices and their assembly, Implicit and explicit formulations, Elasto-plastic approximations, Lagrangian Vs Eularian schemes, Material integration schemes, and auxiliary equations for contact, friction and incompressibility, Thermo-mechanical problem formulation.

Suggested Readings

1. Metal Forming Analysis- R.H. Wagoner, Cambridge University Press.
2. Theory of Elasticity-Dally and Riley
3. Mechanical Metallurgy- Dieter, McGraw Hill Inc.
4. An Introduction to the Principles of Metal working by Rowe, Arnold.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Elastic properties and stress strain relations	https://www.youtube.com/watch?v=qZRFTIXADp4
	True Stress & Strain	https://www.youtube.com/watch?v=AkX6JqlWRqc
	Theories of failure	https://www.youtube.com/watch?v=xkbQnBAOFEg
	Slip Line field theory	https://www.youtube.com/watch?v=XCS3LqLssLw
UNIT-II	Metal forming technology	https://archive.nptel.ac.in/courses/112/107/112107250/
	Plasticity working of metals	https://archive.nptel.ac.in/courses/112/103/112103279/
	Analysis of Forging Process	https://www.youtube.com/watch?v=yc8UPMZ1FNA
	Analysis of wiredrawing process	https://www.youtube.com/watch?v=3jEROaVF_yQ
UNIT-III	Lubrication in metal forming processes	https://www.youtube.com/watch?v=7fGVT-U3CbQ
	Effects of temperature and strain rate in metal working	https://www.youtube.com/watch?v=xxva7b5O6m0
UNIT-IV	Introduction to Finite Element Methods	https://www.youtube.com/watch?v=C6X9Ry02mPU
	FEM approach for Rolling Process	https://www.youtube.com/watch?v=CZTQHZ6tBQw

Course Code	**PCC-MTME-109A**				
Category	Professional Core Courses				
Course Title	**Mechatronics and Product Design**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Learn the fundamentals and components of mechatronics systems, including sensors, actuators, and controllers. • Learn the concepts of Logic gates, flip-flops, and sequential logic. • Familiarize with mathematical modeling and system dynamics, including transfer functions for mechatronics systems. • Enable to design and simulate mechatronics products using tools.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the technical terminologies related to mechatronics and product design.
CO2	Explain the fundamental principles of mechatronics, including the integration of mechanical, electrical, and electronic systems.
CO3	Apply mechatronics principles to develop control systems for mechatronics devices.
CO4	Analyze the performance of mechatronic systems, considering factors like precision, efficiency, and reliability.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Introduction** to Mechatronics systems and components, Principles of basic electronics- Digital logic, number system logic gates, Sequence logic flip flop system, JK flip flop, D- flip flop. Micro process and their applications- Microcomputer computer structure/micro controllers, Integrated circuits-signal conditioning processes, various types of amplifiers, low pass and high pass filters.
Unit-II	**Sensors-sensors and transducers:** Displacement, position proximity sensors, velocity, forces sensors. Fluid pressure temperature, liquid level and light sensors. Selection of sensors. Actuators, Pneumatic and hydraulic systems, Mechanical actuation system. Electrical calculation system. Other Electrical/ Electronic hardware in Mechatronic system.

Unit-III	**Principles of Electronic system communication**, Interfacing, A. D. and D.A. Converters. Software and hardware principles and tools to build mechatronic systems. Basic system models mathematical models, mechanical and other system Building blocks. System models-Engg. Systems, rotational, translation, elected mechanical, Hydraulic mechanical system. System Transfer functions. First-second order system in series
Unit-IV	**Design and selection of mechatronics systems** namely sensors line encoders and revolvers, steppe rand servomotors Ball screws, solenoids, line actuators and controllers with application to CNC system, robots, consumer electronics products etc., Design of a Mechatronic Product using available softwares.

Suggested Readings

1. Mechatronics by W. Bolton, published by Addison Worley Longman Pvt. Ltd., India Brander, Delhi.
2. Automation Production System and CIMS by Mikell P Groover, Prentice Hall of India Pvt. Ltd, New Delhi.
3. Production Systems and CIM, Groover, PHI.
4. Flexible Manufacturing systems, by Maleki, Prentice Hall.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction To Digital Circuits	https://nptel.ac.in/courses/117106086
	S-R, J-K and D Flip Flops	https://www.youtube.com/watch?v=2ecMG_OciLo
	Micro process and their applications	https://youtu.be/iXSXIJn_Xwc?si=AfT54TfGj4gQ7V0m
UNIT-II	Position proximity sensors, velocity.	https://archive.nptel.ac.in/courses/115/107/115107122/
	Pneumatic and hydraulic systems,	https://archive.nptel.ac.in/courses/112/106/112106300/
	Mechanical actuation system	https://www.youtube.com/watch?v=BUxClwVA7f8
UNIT-III	Principles of communication system	https://archive.nptel.ac.in/courses/108/104/108104091/
	Hydraulic mechanical system.	https://archive.nptel.ac.in/courses/112/103/112103249/
	System Transfer functions	https://www.youtube.com/watch?v=fyLlgjy3Xi8
UNIT-IV	Sensors and actuators	https://archive.nptel.ac.in/courses/108/108/108108147/
	Stepper Motors	https://www.youtube.com/watch?v=oZGLLDjwwrw
	Design and selection of Mechatronics systems	https://youtu.be/LX2oxCz8cU4?si=HvOTdJpK9p7LnVaI

Course code	**LC-MTMD-111A**				
Category	Lab Courses				
Course title	**Experimental Stress Analysis Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Understand the principles and applications of strain gauges in measuring mechanical strain on different surfaces. ● Learn the correct procedures for installing and fixing strain gauges on various surfaces to ensure accurate measurements. ● Explore the fundamentals of photo elasticity through hands-on experiments using a photo elastic bench. ● Gain proficiency in setting up and calibrating a polariscope for analyzing stress patterns in models				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Determine strain on surfaces using strain gauges and understand related temperature effects.
CO2	Demonstrate skill in fixing strain gauges securely and correctly on various surfaces.
CO3	Demonstrate photo elastic bench to study stress patterns in experimental models.
CO4	Use a polariscope to evaluate stress distribution in photo elastic models and interpret the results for various loading conditions.

List of Experiments

Sr. No.	**Contents**	**COs**
1	Experiments using strain gauges.	**CO1**
2	Measurement of strain, temperature effects	**CO1**
3	Fixing of gauges on surfaces.	**CO2**
4	Experiments using photo elastic bench.	**CO3**
5	Setting of polariscope and calibration of disc, beam and tension model.	**CO4**

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
Experiments using strain gauges.	https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor/index.html

Measurement of strain, temperature effects	https://sl-coep.vlabs.ac.in/exp/characterize-temperature-sensor/index.html https://sl-coep.vlabs.ac.in/exp/temperature-sensor/ https://www.youtube.com/watch?v=Kh8DMrZWSiY
Fixing of gauges on surfaces.	https://www.youtube.com/watch?v=N-FdzDciAZI
Experiments using photo elastic bench.	https://www.youtube.com/watch?v=n6nADZCjWWU https://www.youtube.com/watch?v=Ta1q9BITrvQ
Setting of polariscope and calibration of disc, beam and tension model.	https://www.youtube.com/watch?v=XSHyBejnN90

Course code	**LC-MTMD-113A**				
Category	Lab Courses				
Course title	**Mechanical Measurement Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Comprehensive understanding of principles of measuring linear displacement, temperature, pressure, and fluid flow using industry-standard sensors and transducers. ● Develop proficiency in using temperature measurement devices. ● Gain hands-on experience with load and strain measurement techniques using load cells and strain gauge-based cantilevers. ● Learn how to record and document measurement data effectively using plotters and recorders for analysis and interpretation				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Demonstrate the ability to apply LVDT, RTD, thermistor, and thermocouple to measure linear displacement and temperature accurately.
CO2	Use the setup with load cells, inductive pickup and strain gauges on a cantilever beam for measuring load and strain.
CO3	Analyze pressure and fluid flow measurements, interpreting the data to understand system performance.
CO4	Evaluate the accuracy of recorded data and generate correct graphical plots using plotters and data recorders.

List of Experiments

Sr. No.	**Contents**	**COs**
1	Measurement of linear displacement and motion using LVDT	**CO1**
2	Temperature measurement using RTD, thermistor, and thermocouple	**CO1**
3	Pressure and fluid flow measurement.	**CO3**
4	Data logging and plotting with plotters and recorders.	**CO4**
5	Inductive pickup and strain gauge setup on a cantilever beam.	**CO2**
6	Load measurement by load cell and strain gauge based cantilever.	**CO2**

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
Measurement of linear displacement and motion using LVDT	https://sl-coep.vlabs.ac.in/exp/lvdt/simulation.html
Temperature measurement using RTD, thermistor, and thermocouple	https://sl-coep.vlabs.ac.in/exp/characterize-temperature-sensor/index.html https://sl-coep.vlabs.ac.in/exp/temperature-sensor/ https://www.youtube.com/watch?v=Kh8DMrZWSiY
Pressure and fluid flow measurement.	https://uorepc-nitk.vlabs.ac.in/exp/flow-through-venturi-meter/videos.html
Inductive pickup and strain gauge setup on a cantilever beam.	https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor/index.html
Load measurement by load cell and strain gauge based cantilever.	https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor/index.html https://www.youtube.com/watch?v=An7UHSsMKWs

Course Code	**SM-MTMD-115A**				
Category	Seminar				
Course Title	**Seminar-I**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	0	0	2	**2**	
Course Objectives	The objectives of this course are • To develop students' ability to effectively present research topics and findings by effective communication. • To improve problem-solving and critical thinking skills of the students. • To expose students to the latest trends and advancements by reviewing and discussing contemporary research.				
Assessment	50 Marks				
End Semester Examination	-				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Identify the trends and advancements in the related field.
CO2	Analyze and synthesize research literature with in-depth reviews of key studies and methodologies.
CO3	Undertake problem identification, formulation, proposing solution and analyze the impact on society, economy and environment.
CO4	Prepare a well-organized report employing elements of effective communication and critical thinking.
CO5	Demonstrate a sound technical knowledge of their research field.

Overview:

This is a course designed to help M. Tech students develop research presentation skills. The focus is on selecting a topic or research paper relevant to their specialization, conducting an in-depth review, and effectively presenting the research findings.

General Guidelines:

Topic Selection	Each student is required to choose the research topic based on published review paper(s) or literature related to their relevant field. The same topic cannot be selected by multiple students.
Approval Process	The selected paper or topic must be approved by the faculty members/committee appointed by the Head of Department.
Presentation Guidelines	Each student will have 30-40 minutes for their presentation, followed by 5 minutes for Q&A.
Evaluation	The presentation will be evaluated by a committee constituted by the Head of Department. The evaluation will be based on:

Parameters for the Evaluation of Seminar

Sr. No.	Parameters	Marks Allotted	Relevant COs
1	Clarity of the topic	10	CO1
2	Literature Survey	10	CO2
3	Content Relevancy	10	CO3
4	Presentation Skills	10	CO4
5	Q&A Response	10	CO5

Course Code	**PCC-MTMD-102A**				
Category	Professional Core Courses				
Course Title	**Theory of Elasticity**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Gain a foundational knowledge of stress, strain, principal values, and Hooke's Law, • Learn compatibility equations, stress functions, boundary conditions, and Fourier series to solve two-dimensional elasticity problems. • Study torsion in bars of different cross-sections and solve advanced elasticity problems in curvilinear coordinates. • Build analytical skills essential for solving real-world elasticity challenges in engineering fields.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the fundamental concepts of stress, strain, and elastic properties of materials.
CO2	Explain stress strain relationship, mathematical formulations of equilibrium, compatibility, and constitutive equations for elastic bodies.
CO3	Apply stress-strain relationships to solve problems in two- and three-dimensional elasticity.
CO4	Analyze the behavior of elastic materials under complex loading conditions.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	State of stress at a point, stress notations, state of strain at a point and notations, states of plane stress and plane strain. Hooke's law and generalized statement of Hooke's law, stress-strain relationships. Concept of principal stress and strain, Mohr's circle.
Unit-II	Compatibility equations, stress function, use of stress function in solution of two dimensional problems in Cartesian coordinates, boundary conditions. Problems of cantilever, supported beam under distributed load of uniform and uniformly variable intensity. Use of Fourier series.

Unit-III	Two dimensional elasticity problems in polar coordinates, equation of equilibrium. Axi-symmetric problems, thick cylinder, curved bars. Hole in a plate problem. Idea of an edge dislocation. Torsion of straight bars, elliptic and circular section. Membrane analogy, torsion of thin rectangular section. Application of energy method to torsion problem. Torsion of thin tubes.
Unit-IV	Complex variables for curvilinear coordinates, Laplace's equation. Complex stress function and corresponding displacements. Curvilinear coordinates and stress components - elliptic hole in a uniformly stressed plate.

Suggested Readings

1. Theory of Elasticity by SP Timoshenko; McGraw-Hill (International student edition).
2. Applied Elasticity by Zhilun Xu; Wiley Eastern Ltd.
3. Applied Elasticity by Chi-Teh Wang; McGraw-Hill.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Generalized Hooke's law	https://www.youtube.com/watch?v=XPURbEDSnQc
	Mohr's circle	https://youtu.be/NJB4nk89qkU?feature=shared
UNIT-II	Fourier series	https://youtu.be/lkAvgVUvYvY?feature=shared
	Two dimensional problems in Cartesian coordinate	https://youtu.be/v0KV1E_9fBs?feature=shared
UNIT-III	Curved bars	https://youtu.be/bK8NdVYX4HQ?feature=shared
	Thick cylinder	https://youtu.be/erW4HZ5I928?feature=shared
UNIT-IV	Laplace's equation	https://youtu.be/iiTOw0JqQFc?feature=shared
	Curvilinear coordinates and stress components	https://youtu.be/DOYVOWCPtJE?feature=shared

Course Code	**PCC-MTMD-104A**				
Category	Professional Core Courses				
Course Title	**Design of Mechanisms**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Learn the fundamental concepts of mobility analysis, including degree of freedom (DOF), mixed mobility, total, partial, and fractional DOF. • Develop the ability to generate alternative design solutions for mechanisms, focusing on coding, evaluation, and selection of the optimum mechanism. • Acquire knowledge of various methods for designing and analyzing mechanisms, including graphical, algebraic, and optimization techniques, as well as matrix methods. • Explore manipulator dynamics from both the Lagrangian and Newtonian perspectives.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the terminology and classifications of mechanisms.
CO2	Explain the working principles and alternative design solutions of various mechanisms.
CO3	Apply graphical, analytical and optimization techniques to synthesize mechanisms for specific motion and force requirements.
CO4	Analyze the performance of mechanisms, including displacement, velocity, and acceleration profiles.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**MOBILITY ANALYSIS** – Degree of freedom (DOF) mixed mobility, total, partial and fractional DOF, closed and open chain systems, structural analysis and synthesis of mechanisms.
Unit-II	Alternative design solutions, coding, evaluation and selection of optimum mechanism, type synthesis, number synthesis and design of mechanisms.
Unit-III	Indexes of merit, graphical, algebraic and optimization techniques, matrix methods of design and analysis, design of function, path and motion generators, structural and mechanical error, design and analysis using software.

Unit-IV	Manipulators – Classification, actuation and transmission systems, coordinate transformation – DH notations, inverse and forward kinematics, manipulator dynamics from Lagrange and Newtonian point of view.

Suggested Readings

1. Mechanism Design Vol – 1,2 by George N Sandor and Arthur G Erdman; Prentice Hall.
2. Theory of Mechanism and Machines by Amitabha Ghosh and AK Mallik; EWLP, Delhi.
3. Theory of Mechanisms by JE Shigley and JJ Vicker; McGraw Hill.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Degree of freedom	https://youtu.be/o0NLi-wJS1I?feature=shared
	Structural analysis and synthesis of mechanisms	https://youtu.be/tviGzaYmKkg?feature=shared
	Closed and open chain systems	https://youtu.be/hQklXllpyy0?feature=shared
UNIT-II	Design of mechanisms	https://youtu.be/tviGzaYmKkg?feature=shared
	Introduction to robotics	https://youtu.be/xKmL_kMxqZw?feature=shared
UNIT-III	Design and analysis using software like ADAMS	https://youtu.be/hGWs39kgnQE?feature=shared
	Matrix methods of design and analysis	https://youtu.be/T2drnetYhIA?feature=shared
UNIT-IV	DH notations	https://youtu.be/K_yvWED--UQ?feature=shared
	Forward kinematics	https://youtu.be/J87P0OjqAsU?feature=shared
	Inverse kinematics	https://youtu.be/unwUt3kkgvE?feature=shared

Course Code	**PEC-MTMD-112A**				
Category	Professional Elective Courses				
Course Title	**Computer Aided Design**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Learn the various 2D and 3D transformations. • Gain knowledge in representing and fitting curves and surfaces using various methods. • Gain proficiency in working with data exchange formats like IGES, STEP, ACIS, and DXF. • Learn assembly modeling techniques, including part modeling, representation, and assembly sequence generation.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the fundamental concepts of computer-aided design, including modeling techniques and CAD tools.
CO2	Explain the principles of transformation, surface modeling, solid modeling, key data exchange formats and algorithms in CAD software.
CO3	Apply transformation matrices, curve fitting methods, solid modeling and mechanical assembly techniques to develop 2D and 3D CAD models for engineering applications.
CO4	Analyze the geometric properties of solid models, examining their feasibility, manufacturability, and structural integrity.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Transformation and Manipulation of Objects**: Introduction, Transformation Matrix, 2D transformation, Arbitrary Rotation about the origin, Rotation by different angles, Concatenation, 2D transformation, Projection on to a 2D plane, Overall scaling, Rotation about an Arbitrary Point, 2D Reflection, 3D Transformation, 3D scaling, 3D Rotation of Objects, 3D Rotation about an arbitrary Axis, 3D Visualization-reconstruction of Three Dimensional Images.
Unit-II	**Description of Curves and Surfaces:** Line Fitting, Non Linear Curve Fitting with a Power Function, Curve Fitting with a High Order Polynomial, Chebyshev polynomial Fit. Fourier Series of Discrete Systems, Cubic Spines, Parabolic Cubic Splines, Non-Parametric Cubic Spline, Boundary Conditions, Bezier Curves, Differentiation of Bezier Curve Equations, B-Spline Curve, Non-Uniform Rational B-Spline(NURBS), Surface creation, Coons patch, tensor product surfaces, Bezier surface, relational parametric surface, parametric spline surface, Lofted surfaces, spline blended surfaces, Tangent and Twisted vectors, Blended surfaces, Application Software.

Unit-III	**Solid Modeling**: Introduction, solid models and entities, solid representation, regularized Boolean operation, Half-spaces, B-Rep and CSG modeling techniques, analytic solid modeling, solid manipulations. **Data exchange Formats**: Shape based formats; product data based formats, ISO standards, IGES- data representation, file structure and formats, processors, PDES- data representation, STEP- architecture and implementation, ACIS and DXF, creating IGES, STEP, ACIS and DXF Files.
Unit-IV	**Mechanical Assembly analysis**: Assembly modeling- parts modeling and representation, Hierarchical relationships, mating conditions, Representation schemes- Graph structure, location Graph, virtual link, generation of assembly sequences: precedence diagram, liaison sequencing analysis, precedence Graph, assembly analysis. **Hidden line and Hidden surface removal algorithms**: Visibility techniques-mini-max test, containment test, surface test, edge interactions, homogeneity test, sorting, coherence, Warnock algorithm, The priority or z- Buffer algorithm, Watkinson Scan line algorithm, Ray tracing algorithm.

Suggested Readings

1. CAD/CAM Theory and Practice by Ibrahim-Zeid; Tata McGraw Hill.
2. CAD/CAM/CIM by P Radhakrishnan; New Age International.
3. Mathematical Elements of Computer graphics by Rogers and Adams; McGraw Hill.
4. Computer Aided Design by Besant and Lui; Prentice Hall.

Useful Video links

Unit No.	Topic	Link
UNIT-I	2D transformation	https://youtu.be/iWxS2zpaRjk?feature=shared
	3D transformation	https://youtu.be/I8o4kK9QRL4?feature=shared
UNIT-II	Introduction to Curve fitting	https://youtu.be/i6ZmA9EEzrI?feature=shared
	Bezier Curve	https://youtu.be/-J2m_ugWNtc?feature=shared
	B-Spline Curve	https://youtu.be/OkncKzflw8I?feature=shared
UNIT-III	Solid Modelling	https://youtu.be/Nh6TxTUKzhA?feature=shared
	B-Rep and CSG modeling techniques	https://youtu.be/6c3-Qqh95r4?feature=shared
UNIT-IV	State Space Representation	https://youtu.be/CrXOMBlYFp0?feature=shared
	Hidden line and Hidden surface removal algorithms	https://youtu.be/OE-Es3bXj90?feature=shared

Course Code	**PEC-MTMD-114A**				
Category	Professional Elective Courses				
Course Title	**Design of Pressure Vessels**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Understanding of the fundamental criteria and codes governing piping design. • Learn how to account for external loads and fatigue in piping systems. • Gain insights into the design of pipe supports, including the selection and assumptions for different types of supports, load combinations. • Acquire knowledge required to design pressure vessels, focusing on internal and external pressures, penetration design, flanges, and cone-cylinder junctions.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the fundamental principles of pressure vessel design.
CO2	Explain the types of stresses and their significance in pressure vessel design.
CO3	Apply the principles and relevant design codes and standards to solve the problems of pressure vessels.
CO4	Analyze the effect of external loads on piping systems and pressure vessels.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Introduction:** Introduction to basic piping design criteria and codes. **Pressure Design:** Wall thickness determination under external pressure, internal pressure and vacuum pressure.
Unit-II	**External Loads and Fatigue Design:** Flexibility, fatigue, stress intensity factors, combined load (sustained wind, earth quake), Cold spring.
Unit-III	**Pipe Support Design:** Support types assumptions, load combinations, variable supports, lugs and attachments, pressure relief, Materials, Fabrication, Inspection and Testing.

Unit-IV	Design of Pressure Vessels**:** Design of Pressure vessels subjects to internal pressure, external pressure, design of penetration, design of flanges, cone cylinder junctions. Prediction of thermal and hydraulic loads, Materials, Fabrication, Inspection and Testing.

Suggested Readings

1. Pressure Vessels: Design and Practice by Somnath Chattopadhyay; CRC Press.
2. Pressure Vessel Design by Donatello Annaratone.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Fundamentals of Pipe Stress Analysis in Piping Design	https://youtu.be/G3rTQJOWMMA?feature=shared
	Vessel under external pressure	https://youtu.be/WiHsX_Lzj_0?feature=shared
UNIT-II	Design of Springs	https://youtu.be/QfhIea6KzZA?feature=shared
	Stress Intensity Factors for Different Geometries	https://youtu.be/UpNVKJkWKhQ?feature=shared
UNIT-III	Pipe Support & its types	https://youtu.be/84Z6pDFMxmc?feature=shared
	Basics of Pipe Supports	https://youtu.be/_5BjlSgr9do?feature=shared
UNIT-IV	Design of Cylinders & Pressure Vessels	https://youtu.be/erW4HZ5I928?feature=shared
	Design of Flanges	https://youtu.be/itEbimufEvM?feature=shared

Course Code	**PEC-MTME-116A**				
Category	Professional Elective Courses				
Course Title	**Materials Management**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Learn the concepts of material management, its functions, and organizational structures. • Study the material planning and control techniques. • Learn about purchasing and supplier management for cost reduction through effective negotiations and purchasing research. • Learn various methods like variety reduction and material flow cost control to optimize material management.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Define the fundamental concepts and principles of materials management, including inventory control, procurement, and materials handling etc.
CO2	Explain the principles and processes of material planning, procurement, and inventory management, and their role in efficient operations.
CO3	Apply techniques of materials management to ensure efficient and cost-effective management of materials in a manufacturing environment.
CO4	Analyze the impact of material management strategies and inventory management methods on production efficiency and organizational profitability.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Introduction:** Introduction to material management and productivity, functions of material management, organization structures in material management, role of material management techniques in improved material productivity. **Material planning**: Objectives, material requirement planning, manufacturing resource planning, JIT production planning, strategic material planning, material control: acceptance, sampling, inspection, make or buy decision, simple cost analysis, economic analysis, break even analysis, break-even point theory, whether to add or drop a product line store management and warehousing, product explosion.
Unit-II	**Purchasing:** Importance of good purchasing system, organization of purchasing functions, purchase policy and procedures, responsibility and limitations, purchasing decisions, purchasing

	role in new product development, role of purchasing role cost reduction, negotiations and purchase, purchasing research: identification of right sources of supply, vendor rating, standardization, vendor certification plans, vendor and supply reliability, developing new source of supply.
Unit-III	**Cost Reduction:** Cost control vs cost reduction, price analysis, material cost reduction techniques, variety reduction, cost reduction and value improvement, techniques of cost control, standard costing, cost effectiveness, cost analysis for material management, material flow cost control**.**
Unit-IV	**Inventory management**: Inventory vs stores, types of inventory, inventory control, inventory build-up, EOQ, various inventory models, inventory models with quantity discount, exchange curve concept, coverage analysis, optimal stocking and issuing policies, inventory management of perishable commodities, ABC - VED analysis, design of inventory distribution systems, surplus management, information system for inventory management, case studies.

Suggested Readings

1. Material management by WR Stelzer Jr; Prentice Hall.
2. Material management by DS Ammer & Richard Erwin.
3. Material management by AK Dutta; Prentice Hall.
4. Material management: An integrated approach by P Gopalakrishnan & M Sundersen; Prentice Hall.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Basic elements of JIT	https://youtu.be/Zjx7zCjLjyw?feature=shared
	Break even analysis	https://youtu.be/KGF1YelPYqA?feature=shared
UNIT-II	Basics of Purchasing Management	https://youtu.be/DdSfqfXOLXk?feature=shared
	Purchasing Cycle & Procurement Development Process	https://youtu.be/H9n5KL4G6_I?feature=shared
UNIT-III	Accounting for Costs	https://youtu.be/yf0WLsrLsXg?feature=shared
	Materials Management	https://youtu.be/4Vs3xcEEU84?feature=shared
UNIT-IV	EOQ model	https://youtu.be/9tJv5COGkD0?feature=shared
	Inventory Control and Management	https://youtu.be/k-9mb4KtaGc?feature=shared

Course Code	**PEC-MTME-118A**				
Category	Professional Elective Courses				
Course Title	**Finite Element Method**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Understand the principles and concepts of the finite element method, including discretization, element types, and the formulation of finite element equations. • Enable to apply FEM and solve engineering problems. • Develop finite element models for a variety of structural and mechanical systems, including linear and nonlinear problems. • Understand the concept of numerical integration for element stiffness.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated
CO1	Define the basic concepts of finite element methods.
CO2	Explain the basic principles of the finite element method, including the discretization of structures, element types, and formulation of governing equations.
CO3	Use FEM techniques to solve complex structural problems, including the analysis of stress, strain, and deformation in various engineering structures.
CO4	Analyze finite element models and behavior of different element types and mesh configurations to ensure the reliability of simulations in engineering applications.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Fundamentals:** Description of method, matrix techniques, large system of algebraic equations, basics of solid mechanics, stress and strain relationships in elastic behavior - linear and nonlinear. Variational methods in solid mechanics, minimum potential energy and minimum complementary energy, application to FE methods.
Unit-II	**Theory of FE Method:** Element shapes, one-, two-, three- dimensional and axisymmetric elements, displacement models in generalized coordinates, convergence, nodal degrees of freedom, interpolation displacement models. Element stresses and strains. Element stiffness and loads, lumped loads. Variational formulation of element stiffness and lumped load, numerical integration, condensation of internal degrees of freedom.
Unit-III	**Assemblage of Elements:** Discretization of a body or structure, effect of element aspect ratio, infinite bodies, higher order elements and refinement of mesh, nodal compatibility and interface displacement compatibility, assembly stiffness matrix. Boundary conditions, solution for element stress or strain.

Unit-IV	**Application of FEM:** Application of FEM to problems in mechanics, fluid flow and heat transfer. Making Computer Codes for FEM solutions.

Suggested Readings

1. Introduction to the Finite Element Method by CS Desai and JF Abel; Van Nostrand Reinhold Co.
2. Finite Element by OC Zienkiewicz.
3. Finite Element Procedure by Klaus-Jurgen Bathe; Prentice Hall.
4. Concept and Applications of Finite Element Analysis by R Cook, D Malkus, M Plesha and R Witt; Wiley

Useful Video links

Unit No.	Topic	Link
UNIT-I	Elastic stress- strain relations	https://youtu.be/o0jav8mpHGM?feature=shared
	Variational Methods	https://youtu.be/hahSt_5mc3A?feature=shared
UNIT-II	Introduction to Finite Element Method	https://youtu.be/KR74TQesUoQ?feature=shared
	Generalized and Principle Coordinates	https://youtu.be/AN8Ip39LXJg?feature=shared
UNIT-III	Assembly of element equations	https://youtu.be/hJmM6CzFRW8?feature=shared
	Finite Element Method	https://youtu.be/KWUcHgXOijs?feature=shared
	Total Stiffness Matrix	https://youtu.be/9bnFVE88PaM?feature=shared
UNIT-IV	Analysis of Trusses Using Finite Element Methods	https://youtu.be/m5Ng0C5ZFJ8?feature=shared
	Computer Coding	https://youtu.be/6nIDdwr9N_E?feature=shared

Course code	**LC-MTMD-106A**				
Category	Lab Courses				
Course title	**Material Testing Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Familiarize students with the UTM and its applications in material testing. ● Provide hands-on experience in conducting fatigue tests to evaluate fatigue strength and creep tests to analyze the deformation of materials under sustained stress at elevated temperatures. ● Develop the ability to analyze test data, including stress-strain curves, S-N curves, and creep deformation curve.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated
CO1	Demonstrate UTM and calculate true stress and true strain values for various materials, understanding material behavior under real-world loading conditions.
CO2	Analyze the strength coefficient (K) and strain hardening exponent.
CO3	Analyze S-N curves to determine fatigue strength.
CO4	Demonstrate creep tests and evaluating a material's suitability for applications involving sustained high temperature and stress.

List of Experiments

Sr. No.	Contents	COs
1	Study of UTM and its applications in material testing.	**CO1**
2	Determination of True Stress and True Strain Using UTM.	**CO1**
3	Determination of Strength Coefficient and Strain Hardening Exponent.	**CO2**
4	Fatigue Test to Determine Fatigue Strength	**CO3**
5	Creep Test to Determine Creep Characteristics	**CO4**

Virtual Lab Links

Experiment Name	Virtual Lab Link
Study of UTM and its applications in material testing.	https://sm-nitk.vlabs.ac.in/exp/tensile-test-mild-steel/procedure.html
Determination of True Stress and True Strain Using UTM.	https://www.youtube.com/watch?v=AkX6JqlWRqc
Determination of Strength Coefficient and Strain Hardening Exponent.	https://www.youtube.com/watch?v=effCCaIjeh8

Fatigue Test to Determine Fatigue Strength	https://eerc01-iiith.vlabs.ac.in/exp/fatigue-test-experiment/
Creep Test to Determine Creep Characteristics	https://eerc01-iiith.vlabs.ac.in/exp/creep-test-experiment/

Course code	**LC-MTMD-108A**				
Category	Lab Courses				
Course title	**Design Practice Lab – I**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Equip students with the ability to create 2D models. ● Create detailed 3D models of complex IC engine components. ● Familiarize students with the working principles, features, and components of CNC machines. ● Enable to Implement G and M codes for programming CNC machines, covering various machining operations.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated
CO1	Create 2D models using CAD software
CO2	Create detailed 3D models of IC engine parts, applying CAD software features
CO3	Understand CNC machine features in order to prepare for industrial applications.
CO4	Develop CNC programs using G&M codes for machining operations.

List of Experiments

Sr. No.	Contents	COs
1	Modeling in 2D and image scanning using CAD software	**CO1**
2	Modeling in 3D of IC Engine parts.	**CO2**
3	To study the general features of CNC machines.	**CO3**
4	Develop program for various machining operations by using G&M codes.	**CO4**

Virtual Lab Links

Experiment Name	Virtual Lab Link
Modeling in 2D and image scanning using CAD software	https://fab-coep.vlabs.ac.in/exp/3d-scanning/theory.html
Modeling in 3D of IC Engine parts.	https://www.youtube.com/watch?v=DM6tFJHsAnc
To study the general features of CNC machines.	http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/exp2/index.html
Develop program for various machining operations by using G&M codes.	https://www.youtube.com/watch?v=5XihF05K4yM

Course Code	**SM-MTMD-110A**				
Category	Seminar				
Course Title	**Seminar-II**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	0	0	2	**2**	
Course Objectives	The objectives of this course are • To develop students' ability to effectively present research topics and findings by effective communication. • To improve problem-solving and critical thinking skills of the students. • To expose students to the latest trends and advancements by reviewing and discussing contemporary research.				
Assessment	50 Marks				
End Semester Examination	-				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**
CO1	Identify the trends and advancements in the related field.
CO2	Analyze and synthesize research literature with in-depth reviews of key studies and methodologies.
CO3	Undertake problem identification, formulation, proposing solution and analyze the impact on society, economy and environment.
CO4	Prepare a well-organized report employing elements of effective communication and critical thinking.
CO5	Demonstrate a sound technical knowledge of their research field.

Overview:

This is a course designed to help M. Tech students develop research presentation skills. The focus is on selecting a topic or research paper relevant to their specialization, conducting an in-depth review, and effectively presenting the research findings.

General Guidelines:

Topic Selection	Each student is required to choose the research topic based on published review paper(s) or literature related to their relevant field. The same topic cannot be selected by multiple students.
Approval Process	The selected paper or topic must be approved by the faculty members/committee appointed by the Head of Department.
Presentation Guidelines	Each student will have 30-40 minutes for their presentation, followed by 5 minutes for Q&A.
Evaluation	The presentation will be evaluated by a committee constituted by the Head of Department. The evaluation will be based on:

Parameters for the Evaluation of Seminar

Sr. No.	Parameters	Marks Allotted	Relevant COs
1	Clarity of the topic	10	CO1
2	Literature Survey	10	CO2
3	Content Relevancy	10	CO3
4	Presentation Skills	10	CO4
5	Q&A Response	10	CO5