GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

An Autonomous Institute

'A' GRADE ACCREDITED BY NAAC

Evaluation Scheme & Syllabus For

Master of Technology (Manufacturing & Automation) 1st Year

(Effective from the Session: 2024-25)

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 Engineering.

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*

**Minor variation is allowed as per need of the respective disciplines.*

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	FLC
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 (M&A) – 1st Semester

w.e.f. 2024-25

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-MTMA-101A	Welding & Allied Processes	4	0	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-MTMA-103A	Foundry Technology	4	0	0	4	4	40	60		100	3
3	Professional Core Courses	PCC-MTMA-105A	Total Quality Management	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 & Product Design	4	0	0	4	4	40	60		100	3
6	Lab Course	LC-MTMA-111A	Mechatronics Lab	0	0	2	2	1	25		25	50	3
7	Lab Course	LC-MTMA-113A	Welding Lab	0	0	2	2	1	25		25	50	3
8	Seminar-I	SM-MT-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 (M&A) – 2nd Semester

w.e.f. 2024-25

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-MTMA-102A	Mechanical Design-I	4	0	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-MTMA-104A	Diagnostic Maintenance & Monitoring	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	3	3	40	60		100	3
6	Foundation Elective Courses	Refer Table -III	.....	3	0	0	3	3	40	60		100	3
7	Lab Course	LC-MTMA-106A	CIM Lab	0	0	2	2	1	25		25	50	3
8	Lab Course	LC-MTMA-108A	Diagnostic Maintenance & Monitoring Lab	0	0	2	2	1	25		25	50	3
9	Seminar-II	SM-MT-110A	.....	0	0	2	2	2	50			50	
Total Credits								**22**				**650**	

Table I (Program Elective Courses)

Courses	Remarks
PEC-MTMA-112A	Quality control techniques
PEC-MTMA-114A	Finite Element Method
PEC-MTMA-116A	Artificial Intelligence in Manufacturing

Table II (Multidisciplinary Open Elective-I Courses)

Students of all M. Tech programmes are required to study one Multidisciplinary open elective course in each of the 2nd and 3rd Semesters 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 Name	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	Remarks	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-MTMA-101A**				
Category	Professional Core Courses				
Course Title	**Welding & Allied Processes**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Comprehensive understanding of welding processes and their impact on the microstructure and properties of weld metal, with a focus on fusion welding • Study the behavior of welding arcs, including arc efficiency, temperature distribution, arc stability, and the role of electrode polarity in arc initiation • Provide knowledge of metal transfer mechanisms in welding, including short-circuit, globular, and spray transfer, and their effects on weld bead geometry and dilution. • Learn solid-state welding techniques such as ultrasonic, friction, explosive welding, and friction stir processing, and their applications.				
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 terminology related to welding processes.
CO2	Explain the principles, processes, and equipment used in various welding techniques.
CO3	Apply various welding processes, including fusion and solid-state techniques, to optimize weld quality.
CO4	Select appropriate weld joints and materials based on the type of welding process and application requirements.

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:** Basic classification of welding processes, weld ability, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and micro structural products in weld metal, epitaxial, cellular and dendrite solidification, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of micro structures and properties of weld metal. Heat affected zone, re-crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals.

Unit-II	**Welding Arc:** Arc efficiency, temperature distribution in the arc; arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiate on and maintenance, role of electrode polarity on arc behavior and arc stability, analysis of the arc. Types of electrodes, AW Sand Indian system of classification and coding of covered electrode for mild steel, Shielding gases and associated mixtures.
Unit-III	**Metal transfer:** Short circuit/dip transfer. Free flight. Globular type. Spray type, Forces affecting metal transfer. Weld bead geometry and shape factors, Weld dilution. Electric arc welding principle, MIG: - welding equipment and processes, shielding gas, types of metal transfer. Tungsten inert gas arc welding (GTAW): -welding equipment, electrodes, inert gases and torches. Submerged arc welding (SAW): -principle of processes, applications, fluxes and welding electrodes used. CO2welding: -difference from MIG welding, Principle of operation, equipment, welding parameters and applications.
Unit-IV	**Solid state welding:** Introduction, main feature sand applications of Ultrasonic welding, Friction welding and Explosive welding friction stir processing and welding. Welding of Plastics: Difficulties in welding of Plastics, Processes for welding of Plastics.

Suggested Readings

1. Welding processes & technology by Dr. R S Parmar Khanna Publishers
2. Welding Engineering & Technology by Dr. R S Parmar Khanna Publishers
3. The Physics of welding by Lancaster Pergaman Press.
4. Welding Technology by Koenigs berger and Adaer; Macmillan.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Classification of welding processes	https://archive.nptel.ac.in/courses/112/107/112107089/
	Weld thermal cycle, Metallurgy of fusion welds	https://archive.nptel.ac.in/courses/112/107/112107089/
	Solidification	https://archive.nptel.ac.in/courses/112/107/112107089/
UNIT-II	Welding arc	https://archive.nptel.ac.in/courses/112/107/112107089/
	Arc maintenance and characteristics	https://archive.nptel.ac.in/courses/112/107/112107089/
	analysis of the arc	https://archive.nptel.ac.in/courses/112/107/112107089/
	Arc efficiency	https://archive.nptel.ac.in/courses/112/107/112107089/
UNIT-III	MIG: - welding equipment and processes	https://archive.nptel.ac.in/courses/112/107/112107089/
	Tungsten inert gas arc welding (GTAW)	https://archive.nptel.ac.in/courses/112/107/112107089/
	Submerged arc welding (SAW)	https://archive.nptel.ac.in/courses/112/107/112107089/
UNIT-IV	Solid State welding	https://archive.nptel.ac.in/courses/112/103/112103273/
	Solid State welding 2	https://archive.nptel.ac.in/courses/112/103/112103273/
	Welding of Plastics	https://www.youtube.com/watch?v=Zj_S3AX7_nM

Course Code	**PCC-MTMA-103A**				
Category	Professional Core Courses				
Course Title	**Foundry Technology**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Familiarize with the applications of foundry technology in manufacturing and advantages and limitations of casting processes. • Study the properties of ferrous and non-ferrous metals and alloys used in casting. • Provide the knowledge of the elements of gating systems, including the design of pouring basins, gates, and risers • Learn special casting methods such as gravity die casting, die casting, investment casting, centrifugal casting, and continuous casting, • Study the methods of repairing, salvaging defective castings and quality control techniques in foundries				
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 terms of foundry technology.
CO2	Explain the principles, materials, and techniques involved in casting processes.
CO3	Apply advanced casting methods, repair techniques and quality control practices while adhering to environmental and safety standards.
CO4	Analyze the properties and parameters to optimize production, minimize defects, and ensure compliance with quality and environmental standards.

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:** Items (Domestic and Engg.) made by foundry technology. Advantage and limitations of foundry technology and other manufacturing process. Castability and factors favoring castability. Ferrous and Nonferrous casting metals and alloys and items made of them. Melting furnaces for cast iron, cast steels, aluminum alloys, brass and bronzes. Solidification of castings.
Unit-II	**Mold design considerations:** Conceptual, functional and production phase. Pattern and core design considerations, traffic rules applications. Examples, case studies. Gating system elements: objectives, practical rules, optimal time filling, types of pouring basin, types of gates, and types of risers.

Unit-III	**Special casting methods:** Gravity die casting, cold chamber die casting, hot chamber die casting, investment casting, centrifugal casting, shell mold casting. Continuous casting.
Unit-IV	**Repair and salvage of castings,** Rough cleaning (Fettling) and surface cleaning of castings. Casting inspection. Heat treatment of castings. Quality control of castings. Pollution control in foundry. Modernization of foundry

Suggested Readings

Text Book(s):

1. Principal of metal casting by Richard W. Heine, Carl R Hoper. Philip C. Rosenthal T, Tata McGraw Hill.
2. Principal of foundry technology by P. L. Jain, Tata Me Graw Hill
3. Foundry practice by W.H. Salmon

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to casting	https://archive.nptel.ac.in/courses/112/107/112107215/
	Melting furnaces	https://archive.nptel.ac.in/courses/112/107/112107083/
	Solidification of castings	https://archive.nptel.ac.in/courses/112/107/112107215/
UNIT-I	Pattern and core design	https://archive.nptel.ac.in/courses/112/104/112104301/
	Gating system elements	https://archive.nptel.ac.in/courses/112/107/112107215/
	Types of gates	https://archive.nptel.ac.in/courses/112/107/112107215/
UNIT-III	Die casting	https://archive.nptel.ac.in/courses/112/107/112107083/
	Investment casting	https://archive.nptel.ac.in/courses/112/107/112107083/
	Centrifugal casting	https://archive.nptel.ac.in/courses/112/107/112107083/
	Continuous casting	https://archive.nptel.ac.in/courses/112/107/112107083/
UNIT-IV	Heat treatment of castings	https://archive.nptel.ac.in/courses/112/107/112107215/
	Quality control of castings	https://archive.nptel.ac.in/courses/112/107/112107083/
	Pollution control in foundry	https://archive.nptel.ac.in/courses/112/107/112107083/

Course Code	**PCC-MTMA-105A**				
Category	Professional Core Courses				
Course Title	**Total Quality Management**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Study the key concepts, principles, and practices of Total Quality Management (TQM). • Learn the tools and techniques used in TQM, including PDSA, Kaizen, Benchmarking, and the Seven Quality Tools, for continuous improvement and problem-solving. • Learn statistical process control (SPC) methods, including Taguchi's design and FMEA, to improve product and process quality • Familiarize about international quality standards such as ISO 9000 and EMS 14001, and conduct quality audits and vendor rating systems for performance measurement.				
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 terminologies of Total Quality Management.
CO2	Explain the principles, philosophies, and frameworks of Total Quality Management and their application in organizations.
CO3	Apply advanced techniques and tools to monitor and improve processes.
CO4	Analyse the performance measures to enhance the organizational outcomes.

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	**TQM Perspective and TQM Implementation**: Quality, Chain Reaction, Dimensions of Quality, Evolution Of Quality, Quality Control, Quality Assurance, Quality Planning, Quality Improvement, Quality Management, Total Quality Management, Cost Of Quality, Classification of Failure Cost, Reducing Costs, Juran's Model of Optimum Quality Costs, Analysis of COQ For Improvement, Analysis of External and Internal Failure Costs, TQM, Elements of TQM, Leadership For TQM, Deeming 14 Points For Top Management, TQM Tools And Techniques, PDSA, Barriers For TQM Implementation.

Unit-II	**TQM principles and Strategies:** Customer Satisfaction & Employee Involvement. Service Quality, Features of Services, The Kano Model, Employee Motivation, Motivation Theory of Individual Employees, Effective Communications, Training and Mentoring, Recognition and Reward. Continuous Process Improvement and Process Approach. Juran's Tribology, Kaizan, PDCA, Seven Quality Tools, BPR, Seven Deadly Wastes, ETX Model, Lean Manufacturing, Kanban System, Cellular Manufacturing, Single Piece Flow, Zero Defects.
Unit-III	**Statistical Process Control & TQM Tools:** The Seven Quality Control Tools, Standard Normal Distribution, AQL, Seven Management Tools, Benchmarking, QFD, Taguchi's Design, TPM, FMEA.
Unit-IV	**Quality Systems:** ISO9000 standard, EMS14001, Quality Awards Supplier Partnership and Performance Measures-Importance of Suppliers, Selection And Standards, Quality Audit, Product Audit, Vendor Rating System, PDCA For Measurements, Performance Measure Design, BSC.

Suggested Readings

1. Total Quality Management by Oakland (Butterworth- Heinemann Ltd.)
2. Managing for total quality from Deming to Taguchi and SPC by Logothetis N.(PHI)
3. Total Quality Control by Feigenbaum A.V. (MGH)
4. Total Quality Management by Besterfield Dale H (Pearson Education)

Useful Video links

Unit No.	Topic	Link
UNIT-I	Quality and its dimensions	https://youtu.be/5pMWmU_8lfI?si=hI0dsNsI2yUMLrz1
	Quality Control	https://youtu.be/xQQ2AWs0hT4?si=EKjvfZUQxU53kai2
	Total quality management	https://www.youtube.com/watch?v=yWlAOFs04go
	Deeming 14 Points	https://archive.nptel.ac.in/courses/110/105/110105088/
UNIT-II	Seven Quality Tools	https://www.youtube.com/watch?v=HQiiRh5GoIc
	Lean manufacturing	https://archive.nptel.ac.in/courses/110/107/110107130/
	Kanban	https://archive.nptel.ac.in/courses/110/107/110107130/
UNIT-III	The Seven Quality Control Tools	https://www.youtube.com/watch?v=6-JVHv5djIc
	TPM	https://www.youtube.com/watch?v=UOuTBCrW2kY
	FMEA	https://www.youtube.com/watch?v=UOuTBCrW2kY
UNIT-IV	ISO 9000	https://archive.nptel.ac.in/courses/110/104/110104080/
	PDCA	https://www.youtube.com/watch?v=4XYS7_NSvLA

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 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 (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	**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 & 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 (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** 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 Mikel 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-MTMA-111A**				
Category	Lab Courses				
Course title	**MECHATRONICS LAB**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Learn to verify and implement basic logic gates and design logic equations using digital circuits. ● Study the integration of mechanical, electrical, and control components to create functional mechatronic systems. ● Explore the use of software tools to automate mechanical movements and utilize DAC systems for precise motion control in mechatronic applications. ● Learn to select appropriate sensors for specific applications				
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	Verify digital logic circuits using basic gates.
CO2	Select appropriate sensors and incorporating mechatronics principles to enhance the product's functionality and value.
CO3	Use software to control and automate motion in mechatronic systems and operate systems with PLC and DAC to control movements in a mechatronic setup.
CO4	Analyze and predict system behavior and performance, with focus on mechatronics and interfacing in CNC machines.

List of Experiments

Sr. No.	**Contents**	**Relevant COs**
1	To verify truth table of various gates such as AND, OR, NOR NOT, etc.	**CO1**
2	To realize a logic equation Y=AB+CD	**CO1**
3	Selection of sensor for a particular application from Catalogue/Internet.	**CO2**
4	Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values.	**CO2**
5	To study the hardware's and softwares of mechatronics kit.	**CO2**
6	To move a table in X-direction within the range of proximity sensors using Control-X software.	**CO3**
7	To rotate a table using DAC system.	**CO3**
8	To move a table in Y-direction within the range of proximity sensors using Control-X software.	**CO3**

9	To ornament to with PLC.	**CO3**
10	To run a conveyor with computer.	**CO3**
11	To study the movement of actuating cylinders and sensors.	**CO3**
12	To study mechatronic and the reinter facing in a CNC machine.	**CO4**
13	Life prediction from computer programme based on mathematical model.	**CO4**

Note: At least 10 experiments are to be performed by the students.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**	**Relevant COs**
To verify truth table of various gates such as AND, OR, NOR NOT, etc.	https://de-iitr.vlabs.ac.in/exp/truth-table-gates/theory.html	**CO1**
To ornament to with PLC.	https://plc-coep.vlabs.ac.in/exp/hardware-software-plc/	**CO3**
To run a conveyor with computer.	https://www.youtube.com/watch?v=GhgFdLDdUIY	**CO3**
To study the movement of actuating cylinders and sensors.	https://sl-coep.vlabs.ac.in/exp/characterize-temperature-sensor/ https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor/	**CO3**
To study mechatronic and the reinter facing in a CNC machine.	http://vlabs.iitkgp.ac.in/cim/exp3/index.html	**CO4**

Course code	**LC-MTMA-113A**				
Category	Lab Courses				
Course title	**Welding Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-I**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Study the tensile properties, bead geometry, hardness, and microstructure of welding beads produced by various welding processes. ● Enable to investigate mechanical properties such as tensile strength, hardness, impact strength, corrosion resistance, wear, and fatigue behavior in materials. ● Explore how different welding techniques influence the grain structure and overall material performance.				
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	Explain heat flow during gas welding and its effects on material properties and weld quality.
CO2	Assess tensile strength, bead geometry, hardness, and microstructure for different welding techniques like MIG, TIG, SAW, and Arc welding.
CO3	Evaluate mechanical behaviors such as impact strength, corrosion resistance, and fatigue for materials processed by friction stir welding and friction stir processing.

List of Experiments

Sr. No.	**Contents**	**Relevant COs**
1	To study Heat flow in Welding (Equipment for use –Gas Welding equipment)	**CO1**
2	To study tensile property, Bead Geometry, Hardness of Bead, Micro structure of welding Bead in case of: i) MIG Welding ii) TIG Welding iii) SAW Welding iv) Arc welding	**CO2**
3	To study mechanical behavior (tensile strength, Hardness of Bead, Micro structure of welding Bead, impact strength, corrosion and wear, fatigue Behaviour) in case of 1. Friction stir welding 2. Friction stir processing	**CO3**

Virtual Lab Links

Experiment Name	Virtual Lab Link	Relevant COs
To study Heat flow in Welding (Equipment for use –Gas Welding equipment)	https://www.youtube.com/watch?v=k7Hjl_1fCkE	**CO1**
To study tensile property, Bead Geometry, Hardness of Bead, Micro structure of welding Bead in case of: i) MIG Welding ii) TIG Welding iii) SAW Welding iv)Arc welding	https://www.youtube.com/watch?v=QVhYIGTVgDA&t=1s	**CO2**
To study mechanical behavior (tensile strength, Hardness of Bead, Micro structure of welding Bead, impact strength, corrosion and wear, fatigue Behaviour) in case of 1. Friction stir welding 2. Friction stir processing	https://www.youtube.com/watch?v=0Sqc9DjpwxI	**CO3**

Course Code	**SM-MT-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

CO	**Skill 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-MTMA-102A**					
Category	Professional Core Courses					
Course Title	**MECHANICAL DESIGN-I**					
Scheme and Credits	L	T	P	**Credits**	**Semester-II**	
	4	0	0	**4**		
Course Objectives	The objectives of this course are • Equip students with methods and skills to generate, develop, and evaluate innovative product ideas. • Teach students how to connect customer needs with design characteristics through QFD and material selection. • Help students learn techniques to simplify assembly processes and improve product reliability. • Introduce students to principles of designing products that are easier and more cost-effective to manufacture. • Provide foundational knowledge of various production technologies used in manufacturing. • Familiarize students with techniques used for joining materials in product assembly.					
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 basics of mechanical design.
CO2	Describe the principles of design for assembly (DFA), design for manufacturing (DFM), and the functions of various production processes.
CO3	Use knowledge of material properties and conceptual design methods to create functional and manufacturable product designs.
CO4	Analyze the compatibility of materials, designs, and production methods to identify potential challenges and opportunities for optimization.

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	**Concept Design :** Brain storming methods and sketching.
Unit-II	**Quality Function Development**: Material Characteristics Mechanical, thermal and electrical properties.
Unit-III	**Design**: Design for assembly. Design for manufacturing.
Unit-IV	**Production technologies**: Metal forming, casting, machining, surface treatment, welding, bonding, fastening, clinching.

Suggested Readings

1. Quality Function development, L. Cohen.
2. Manufacturing Engg.: Principles for Organization, D.T. Koenig.
3. Materials Science and Engineering: An Introduction, W.D. Callister Jr.
4. Handbook of Aluminum: Alloy Production and Materials Manufacturing Vol.2, G.E. Totten.
5. CAD Software Catia, Dassault system.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Concept Design : Brain storming method sand sketching	https://www.youtube.com/watch?v=sLi7oHicHCU
		https://youtu.be/MAxqEV8u0aQ?si=68Bfm9e3Xy0mq_6s
		https://youtu.be/DTbijbgUC30?si=tu5QTzwUlOKySkLV
UNIT-II	Quality Function Development Material Characteristics Mechanical, thermal and electrical properties	https://www.youtube.com/watch?v=jS_nXHJG3ZU
UNIT-III	Design for assembly. Design for manufacturing.	https://youtu.be/udM9CrT38AM?si=cR6I9no2wAi29V4Y
UNIT-IV	Metal forming, casting, machining, surface treatment, welding, bonding, fastening, clinching.	https://youtu.be/jdFrBtHeJbs?si=4xh9KrEkRBLm1zaK

Course Code	**PCC-MTMA-104A**				
Category	Professional Core Courses				
Course Title	**Diagnostic Maintenance & Monitoring**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Learn the foundational concepts of maintenance management, its relevance, and the role of automation in maintenance strategies. • Explore different types of failure analyses, including FTA, FMEA, and FMECA. • Familiarize students with condition monitoring techniques, including non-destructive testing (NDT). • Understand the principles of Total Productive Maintenance (TPM), its implementation process, and its impact on productivity improvement and reliability.				
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 basis of diagnostic maintenance & monitoring.
CO2	Explain equipment failures techniques and maintenance management strategies based on the nature and frequency of failures.
CO3	Apply condition monitoring techniques, such as vibration and temperature analysis, and analyzing data from these methods to make informed decisions about predictive maintenance needs.
CO4	Analyse TPM systems by following the basic principles and procedures to improve productivity and enhance the overall reliability of manufacturing systems.

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	**Maintenance Management :** Relevance of maintenance, maintenance: an overview, maintenance services, problems of the plant manager, automation and maintenance, maintenance objectives and costs, quality and quality circle in maintenance, Engineering reliability, maintainability.
Unit-II	**Failure analysis :** Defect generation types of failures, FTA, FMEA, FMECA Maintenance Types/systems Planned and unplanned maintenance, breakdown, corrective, opportunistic, routine, preventive, predictive, CBM, Design out maintenance.

Unit-III	**Condition monitoring :** NDT concepts ,visual and temperature monitoring, leakage monitoring, vibration monitoring, lubricant monitoring methods, equipments, ferrography, spectroscopy, cracks monitoring, thickness monitoring, corrosion monitoring, noise monitoring, sound monitoring, smell monitoring
Unit-IV	**Total productive maintenance**: Development and scope of concept, terotechnology, basic systems of TPM procedure and steps of TPM, productivity circle

Suggested Readings

1. Maintenance planning and Control-Kelly, A. Buttersworth&Co.1984
2. Maintenance and spare parts Management–Krishanan G, Prentice Hall–1991

Useful Video links

Unit No.	Topic	Link
UNIT-I	TQM	https://youtu.be/5pMWmU_8lfI?feature=shared
	Reliability	https://youtu.be/Yukes35HeCM?feature=shared
UNIT-II	FMECA	https://archive.nptel.ac.in/courses/112/105/112105232/
	FMEA	https://youtu.be/ffKaRuNx84M?feature=shared
UNIT-III	Condition Monitoring	https://youtu.be/j_Xpzzo0iko?feature=shared
	NDT concepts	https://youtu.be/DK1dItnI8mM?feature=shared
UNIT-IV	Total Productive Maintenance	https://youtu.be/UOuTBCrW2kY?feature=shared
	Productivity	https://youtu.be/Au6GGv93R5E?feature=shared

Course Code	**PEC-MTMA-112A**				
Category	Professional Elective Courses				
Course Title	**QUALITY CONTROL TECHNIQUES**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	4	0	0	**4**	
Course Objectives	The objectives of this course are • Understand statistical concepts in quality control to evaluate variation in process and product quality. • Analyze control charts to distinguish between chance and assignable causes of variation. • Interpret control chart parameters to determine process settings and assess capability. • Apply probability theory and operating characteristic curves to design effective sampling plans. • Assess quality protection in sampling plans using Average Outgoing Quality (AOQ) and Average Outgoing Quality Limit (AOQL).				
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 basics of quality control techniques.
CO2	Explain the fundamental principles of quality control, process control, and the role of quality assurance in manufacturing and service industries.
CO3	Apply control charts, tools and theorems to monitor and control product quality during production.
CO4	Analyze the impact on quality assurance and process performance.

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	Statistical concepts in Quality Control, variables and attributes, Graphical Representation, Continuous and Discrete Probability Distributions, control limit Theorem. Introduction to Quality Control, process Control and Product Control ,Chance and Assignable causes of Quality variation, Advantages of Shewhart control charts, Process Control charts for variables, X, R and P charts, fixation of control limits, Type I and Type II Errors
Unit-II	Theory of runs, Interpretation of Out of Control points, Probability limits, Initiation of control charts, Trial control limits, Determination of aimed at value of Process Setting, Rational method of sub grouping, control chart parameters, control limits and specification limits, Natural tolerance limits, Relationship of a process in Control to upper and lower specification limits, process capability studies

Unit-III	Special control charts for variables, group control chart, control charts with large sub groups, control chart with reject limits, use of control limits for moving averages Variables inspection and Attributes inspection, Relative merits and demerits, Control charts for Attributes, p chart and n p chart, varying control limits, high defectives and low defectives, CUSU M or Cumulative sum control chart, Average run length (ARL) Relative efficiency or sensitivity of control chart.
Unit-IV	Probability theory binomial and Poisson distribution, Acceptance Inspection, 100% Inspection, No Inspection and sampling Inspection, (O.C.curve). Effect of sample size and Acceptance number operating characteristic curve, type A and type B. O.C. curves, Single, Double and Multiple sampling Plans, SS Plan. Acceptance/Rejection and Acceptance/Rectification Plans, Producers Risk and Consumer's Risk, Indifference Quality level, Average Outgoing quality (AOQ) curve, AOQL ,quality protection offered by a sampling Plan

Suggested Readings

1. Statistical Quality control by E.L. Grant
2. Quality control and Industrial Statistics, by A.J. Duncan
3. Quality control by Dale H. Besterfield
4. Total Quality Control by A. V. Feigenbaum
5. Elementary S.O.L. by I. W. Burr, M. Dekker

Useful Video links

Unit No.	Topic	Link
UNIT-I	Statistical Concepts in Quality Control	https://www.youtube.com/watch?v=yRG1zfqxID4
	Probability Distributions	https://www.youtube.com/watch?v=b9a27XN_6tg
	Control Charts	https://www.youtube.com/watch?v=Aj7lJLR-7b4
UNIT-II	Trial Control Limits	https://www.youtube.com/watch?v=cTsVqOIYyDM
	Rational Method of Sub Grouping	https://www.youtube.com/watch?v=ocfNbNU3xxM
	Process in Control	https://youtu.be/1IhsnvXWkmo?si=sFF_-d0s0rKtIQp7
UNIT-III	Special Control Charts for Variables	https://www.youtube.com/watch?v=yUnDWQ5GmaE
	Variables Inspection and Attributes Inspection	https://www.youtube.com/watch?v=qmNzDzLeoT4
	P and N Chart	https://www.youtube.com/watch?v=p-gvwkHePaU
UNIT-IV	Binomial and Poisson Distribution	https://www.youtube.com/watch?v=c06FZ2Yq9rk
	Operating Characteristic Curve	https://www.youtube.com/watch?v=JE2gfjMj144
	Average Outgoing Quality Limit	https://www.youtube.com/watch?v=-fenqKOEW7E

Course Code	**PEC-MTMA-114A**				
Category	Professional Elective Courses				
Course Title	**Finite Element Methods**				
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 Procedures 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
5. Practical finite element analysis by Nitin S Gokhale, Desh Pande, Bedekar & Thite, Finite to infinite, Pune

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	**PEC-MTMA-116A**				
Category	Professional Elective Courses				
Course Title	**Artificial Intelligence In Manufacturing**				
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, scope, and applications of artificial intelligence in the manufacturing industry. • Understanding of expert systems' architecture, development processes, and applications in manufacturing. • Explore knowledge representation methods, heuristic search techniques, and reasoning strategies for problem-solving in AI. • Familiarize students with practical AI applications in manufacturing domains, including CAD, CAPP, scheduling, and maintenance, through case studies and examples.				
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 artificial intelligence and its role in manufacturing.
CO2	Explain the fundamental concepts of artificial intelligence and its applications in manufacturing, including machine learning, neural networks, and robotics.
CO3	Apply artificial intelligence in manufacturing to optimize manufacturing processes, improve quality control, and enhance production efficiency.
CO4	Analyze expert systems for various manufacturing domains, comparing their architectures with procedural programming, and implement them for 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	Definition, basic concepts of artificial Intelligence, scope, role and potential of artificial intelligence in manufacturing, Expert systems, Popular AI application.
Unit-II	Overview of Expert systems, architecture, comparison with procedural programming, developing Expert system of typical manufacturing domains, implementation and maintenance, state- of-art Expert system application, case study.
Unit-III	All theory problems, problem spaces and search, Heuristic search technique, Knowledge acquisition and knowledge representation, predicate logic, procedurals, Declarative knowledge, forward V/s backward reasoning AI architecture, overview of advanced features and planning, learning, natural language processing, neural nets, fuzzy logic, object oriented programs.

Unit-IV	Case studies, examples of AI, theoretical concepts to manufacturing problems, CAD, CAPP, scheduling GT, CIM system. Domains welding, casting, forming, metal cutting, maintenance

Suggested Readings

1. Artificial Intelligence: A Modern Approach, Second Edition, Russell, S. and Norvig, P., Pearson Education.
2. Machine Learning, First Edition, Dutt, S., Chandramouli, S. and Das, A.K. Pearson Education
3. Artificial Intelligence in Manufacturing: Applications and Case Studies by Masoud Soroush, Richard D Braatz.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to AI	https://youtu.be/pKeVMlkFpRc?feature=shared
	Basic concepts of artificial Intelligence	https://youtu.be/NCq26BvEYIg?feature=shared
UNIT-II	Expert Systems	https://www.youtube.com/watch?v=nE5c5w4aizU
	Functional, Procedural & Object-oriented Programming	https://www.youtube.com/watch?v=aoE-92Ac4zE
UNIT-III	Fuzzy Sets, Logic and Systems	https://youtu.be/K7S3TgfqnX0?feature=shared
	Neural Networks	https://youtu.be/xbYgKoG4x2g?feature=shared
UNIT-IV	Computer aided manufacturing and process planning	https://youtu.be/20_K7c65Swg?feature=shared
	Group Technology	https://youtu.be/1EiGhdMfjok?feature=shared

Course code	**LC-MTMA-106A**				
Category	Lab Courses				
Course title	**CIM LAB**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To study the general features and capabilities of CNC machining and turning centers ● Use and control of robotic systems in applications. ● Understand the functionality and applications of Automated Guided Vehicles. ● Explore the configuration and role of CMMs and machine vision in quality control and their applications in a CIM environment..				
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	Understand and create CNC part programs for various components.
CO2	Understand the applications of robotic systems in ASRS and FMS, and their role in improving automation and efficiency in manufacturing.
CO3	Analyze the working principles and applications of Coordinate Measuring Machines (CMM) and Automated Guided Vehicles (AGVs) in a Computer Integrated Manufacturing (CIM) environment.
CO4	Apply machine vision technologies for quality control and understand the integration of conveyor systems within CIM environments..

List of Experiments

Sr. No.	**Contents**	**Relevant COs**
1	To study general features of Machining Center.	**CO1**
2	To prepare the CNC part program for machining a prismatic component on CNC Machining centre.	**CO1**
3	To study the general features of a CNC Turning center.	**CO1**
4	To prepare the CNC part program for machining of a Cylindrical Component.	**CO1**
5	Study and Applications of Robotic system in Automated storage and Retrieval system.	**CO2**
6	Application and Control of robotic system in Flexible manufacturing System.	**CO2**
7	To study the general features of Automated Guided Vehicle.	**CO3**
8	To study the general configuration of CMM and its Application in CIM environment.	**CO3**
9	Machine Vision and Quality Control in CIM environment.	**CO4**
10	Study and Applications of Conveyer System in CIM system.	**CO4**
11	Study and application of CIM software.	**CO4**

Note: At least 10 experiments are to be performed by the students.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**	**Relevant COs**
To study general features of Machining Center.	https://www.youtube.com/watch?v=8EfEWZLgM-w	**CO1**
To prepare the CNC part program for machining a prismatic component on CNC Machining centre.	https://www.youtube.com/watch?v=5XihF05K4yM	**CO1**
To study the general features of a CNC Turning center.	https://www.youtube.com/watch?v=jym9H6p9-3U&t=444s	**CO1**
To prepare the CNC part program for machining of a Cylindrical Component.	https://www.youtube.com/watch?v=VvDCB8Y2SjQ	**CO1**
Study and Applications of Robotic system in Automated storage and Retrieval system.	https://www.youtube.com/watch?v=POb_zniNqPM	**CO2**
Application and Control of robotic system in Flexible manufacturing System.	https://www.youtube.com/watch?v=uhl4jEQT_aQ	**CO2**
To study the general features of Automated Guided Vehicle.	https://www.youtube.com/watch?v=dNYKcbgbY1A	**CO3**
To study the general configuration of CMM and its Application in CIM environment.	https://www.youtube.com/watch?v=BPQI1xMXC04 https://www.youtube.com/watch?v=oyhnglr_HiY	**CO3**
Machine Vision and Quality Control in CIM environment.	https://www.youtube.com/watch?v=w8oEJgnO0S0	**CO4**

Course code	**LC-MTMA-108A**				
Category	Lab Courses				
Course title	**Diagnostic Maintenance & Monitoring Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-II**
	0	0	2	1	
Course Objectives	The objectives of this course are ● Introduce various maintenance techniques and their importance in industrial applications. ● To study and perform NDT techniques. ● Understand and use diagnostic tools for wear analysis and equipment inspection. ● Study the role and applications of diagnostic maintenance techniques. ● Learn strategies for maintenance planning and control, focusing on efficient work planning and management in large industrial setups.				
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	Explain the fundamentals of maintenance techniques and apply them to improve machine reliability.
CO2	Explain Non-Destructive Testing (NDT) techniques such as liquid dye penetration, leak testing, and perform visual inspection using Boroscope and Flexiscope.
CO3	Apply techniques such as Eddy current testing, ultrasonic testing, thermography, and ferrography for wear analysis and fault detection.
CO4	Apply maintenance planning, work control, and diagnostic maintenance practices in large industrial plants such as sugar mills or power plants.

List of Experiments

Sr. No.	**Contents**	**Relevant COs**
1	To study the introduction to maintenance techniques. Preventive and predictive Maintenance	**CO1**
2	To study and perform Non-Destructive Testing techniques, liquid dye penetrates and leak testing.	**CO2**
3	To study and perform, Boroscope, Flexiscope.	**CO2**
4	To study and perform Eddy current testing &Ultrasonic testing	**CO3**
5	To study and perform Magnetic particle detection and Particle counter.	**CO3**
6	To study wear Analysis through thermography and Ferrography.	**CO3**
7	To study the applications of Diagnostic Maintenance to Industrial Machines and plants such as Sugar Industry or Textile Mills or Thermal Power plants and Railways.	**CO4**
8	To study the Maintenance planning and control of a large factory, work planning and work control.	**CO4**

Virtual Lab Links

Experiment Name	Virtual Lab Link	Relevant COs
To study the introduction to maintenance techniques. Preventive and predictive Maintenance	https://www.youtube.com/watch?v=4wneZDEB3VA	**CO1**
To study and perform Non-Destructive Testing techniques, liquid dye penetrates and leak testing.	https://www.youtube.com/watch?v=iwasC3G141w	**CO2**
To study and perform Eddy current testing & Ultrasonic testing	https://www.youtube.com/watch?v=tZBA1L2GkHg	**CO3**
To study and perform Magnetic particle detection and Particle counter.	https://www.youtube.com/watch?v=lD95ri6F2YY	**CO3**
To study wear Analysis through thermography and Ferrography.	https://www.youtube.com/watch?v=piJh0UFdNNw https://www.youtube.com/watch?v=PlZZOWREtvY	**CO3**

Course Code	**SM-MT-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

CO	**Skill 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