

Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

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Course Contents for M. Tech. in Automation Engineering

From 1st Semester - 4th Semester

Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after the holistic development of students and conducting need-based research and extension activities.

Post Graduate Attributes

The Post Graduate Attributes are the knowledge skills and attitudes which the students have at the time of post-graduation. These Post Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of engineering problems involving research.
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for engineering problems involving research and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to research activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the research based engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice to research problems.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader of a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO1	To train students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of Automation Engineering.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career.

Program Outcomes

At the end of the program the student will be able to:

PO1	Acquire, demonstrate and apply advanced knowledge in the area of Automation engineering.
PO2	Identify problems in the field of Automation engineering, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, advanced software and engineering tools to model, analyze and solve Automation engineering problems.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of Automation systems.
PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.
PO10	Examine critically the outcomes of one's actions and make corrective measures subsequently.
PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
BSH:	Basic Science and Humanity
BSC:	Basic Sciences Course
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Professional Elective Course
BHC:	Basic Humanity Course
ESC:	Engineering Science Course
HSMC:	Humanity Science and Management Course
NCC:	National Cadet Corps
NSS:	National Service Scheme

Master of Technology
(Automation Engineering)
 Syllabus with effect from July 2018

Semester-I

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
			L	T	P		Theory		CA	PR/OR	Total
							TH	Test			
ME-XX11	PCC	Industrial Automation	3	1	--	4	60	20	20	--	100
ME-XX12	PCC	Robotics and CNCs	3	1	--	4	60	20	20	--	100
ME-XX13	PCC	Data Analytics for Automation	3	1	--	4	60	20	20	--	100
ME-XX14A	Elective I	Introduction to Mechanical Engineering*	3	--	--	3	60	20	20	--	100
ME-XX14B		Introduction to Electronics and Electrical Engineering#									
ME-XX15A	Elective II	Simulation, Modeling and Control	3	--	--	3	60	20	20	--	100
ME-XX15B		Artificial Intelligence and Expert System in Automation									

ME-XX15C		Hydraulics, Pneumatics and Fluidic Control									
ME-XX15D		Process Control and Automation									
MME15E		Finite Element Method									
ME-XX15F		Virtual Instrumentation									
BSH16	HSMC	Communication Skills	2	--	--	2	--	--	25	25	50
ME-XX17	PCC	PG Lab	--	--	3	2	--	--	25	25	50
Total			17	3	3	22	300	100	150	50	600

* For students with Electronics/Electrical/ Computer Engineering and related background

For students with Mechanical Engineering and related background

Semester-II

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
			L	T	P		Theory		CA	PR/OR	Total
							TH	Test			
ME-XX21	PCC	Drives and Control System for Automation	3	1	--	4	60	20	20	--	100
ME-XX22	PCC	Sensors, Microprocessors, Microcontrollers and their applications	3	1	--	4	60	20	20	--	100
MMECH23A	Elective III	Numerical Methods and Computational Techniques	3	--	--	3	60	20	20	--	100
ME-XX23B		CAD-CAE									
MCADM23C		Flexible Manufacturing System									
ME-XX23D		Machine Vision									
ME-XX24A	Elective IV	Mechatronics	3	--	--	3	60	20	20	--	100
MCADM24B		Design For Mechanisms and Manipulators									
MME24C		Metrology and Computer Aided Inspection									
MOE25A	Elective V	Research Methodology	3	--	--	3	60	20	20	--	100
MOE25B		Design of Experiments									

MOE25C		Advanced Optimization Techniques									
MOE25D		Environmental Engineering and Pollution Control									
MOE25E		Soft Computing Techniques									
MOE25F		Manufacturing Automation									
ME-XX26	PCC	Seminar	--	--	4	2	--	--	50	50	100
ME-XX27	PCC	Mini Project	--	--	4	2	--	--	50	50	100
Total			15	2	8	21	300	100	200	100	700

Semester-III

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
			L	T	P		Theory		CA	PR/OR	Total
							TH	Test			
MMECH31	PCC	Project Management (Self Study Course)	--	--	--	2	--	--	50	50	100
MMECH32		OR Intellectual Property Rights (Self Study Course)	--	--	--	2	--	--	50	50	100
ME-XX33	PCC	Project Stage -I	---	--	--	10	--	--	50	50	100
Total			---	--	--	12	--	--	100	100	200

Semester-IV

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
			L	T	P		Theory		CA	PR/OR	Total
							TH	Test			
ME-XX41	PCC	Project Stage -II	---	--	--	20	--	--	100	100	200
Total			---	--	--	20	--	--	100	100	200

Semester-I
Industrial Automation

ME-XX11	Industrial Automation	PCC	3-1-0	4 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: Nil

Course Outcomes:

At the end of the course the student will be able to

CO1	Understand the need of automation
CO2	Classify various types of automated transmission lines and components of automation.
CO3	List and understand various material handling systems.
CO4	Design various types of automated assembly systems
CO5	Explain various automatic inspection systems
CO6	Develop simple automation programs using PLCs

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			2	3	1	2	1			
CO2	3				2	2	1		2			
CO3	3				1	1	1		1			
CO4	2	2	3		3	2	2		2			
CO5	2				2	1	2		1			
CO6	2	3	3	3	2	2						

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-I: Introduction

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process.

Unit-II: Detroit-Type Automation

Automated Flow lines, Methods of Work-part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations.

Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.

Unit-III: Material handling and Identification Technologies

The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.

Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multistation Assembly Machines, Analysis of a Single Station Assembly Machine.

Unit-IV: Control Technologies in Automation

Industrial Control Systems, Process Industries Verses Discrete- Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, SCADA System & RTU.

Unit-V: Automated Inspection and Testing

Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.

Unit-VI: Programmable Logic Controllers (PLCs)

Introduction, Micro PLC, Programming a PLC, Logic Functions, Input & Output Modules, PLC Processors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison & Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLC Programming Exercises for Industrial Applications.

Text Books:

1. "Automation, Production Systems and Computer Integrated Manufacturing"- M.P. Grover, Pearson Education.

Reference Books:

1. "Computer Based Industrial Control" – Krishna Kant, EEE-PHI
2. Principles and Applications of PLC – Webb John, Mcmillan 1992
3. "An Introduction to Automated Process Planning Systems" – Tiess Chiu Chang & Richard A. Wysk
4. "Anatomy of Automation" – Amber G.H & P.S. Amber, PrenticeHall.

Robotics & CNCs

ME-XX12	Robotics & CNCs	PCC	3-1-0	4 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: Engineering mathematics-I

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify various types of robotic configurations
CO2	Select appropriate type of drive, gripper and sensor for Robot
CO3	Recommend appropriate robot configurations for various applications.
CO4	Understand various implementation issues for robotics
CO5	List various components of a typical CNC system
CO6	Develop NC and APT programme for machining using CNC Machine tools

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1	1					
CO2	2	2			3	2						
CO3		2			2	1		3				
CO4	2	3				3		3				
CO5	2				3		1					
CO6				3		2						

Course Contents:

Unit I: Introduction

Robot configurations, Robot Anatomy Basic Components of Robot Systems: Manipulators, end effectors, sensors, controllers etc. Mechanical System in Robotics: Robot motion analysis and control, Homogeneous transformations and robot kinematics, Kinematic chains, position analysis.

Unit II: Drives for Robot

Stepper motor, DC motors, AC motors, hydraulic and pneumatic systems, drive selection for robotics joints

Unit III: Robotic grippers and Sensors

Linkage activated mechanical grippers, adhesive grippers, magnetic grippers, collets, scoops, expansion bladders, etc.
Sensors in Robotics: Position sensor, velocity sensor, proximity sensors, touch sensors, force sensors.

Unit IV: Applications of Robots

Application of robots in Material Handling, process operations and Assembly and inspection

Unit V Robot Implementation Issues

Approach for implementing Robotics, Safety, Training and Maintenance Social Aspects of Robotics

Unit VI: Computer Numerical Control Machines (CNCs)

Numerical Control, Elements of a NC system, Steps in NC based manufacturing, Point to point, straight line and contouring control, Manual and Computer Assisted Part Programming, NC and APT programming, Adaptive control, Distributed Numerical Control.

TEXTS:

1. M. P. Grover, *Industrial Robotics: Technology, Programming and Applications*, McGraw-Hill International Editions
2. Grover, M.P., Zeemer, *CAD/CAM/CIM*, Prentice Hall, India
3. Saeed B. Niku, *Introduction to Robotics, Analysis, Systems, Applications*, Pearson Education

REFERENCES:

1. Y. Koren, *Robotics for Engineers*, McGraw Hill International Editions
2. Richard D. Klafter, et.al., *Robotic Engineering: An Integrated Approach*, Prentice Hall of India

Data Analytics for Automation

ME-XX13	Data Analytics for Automation	PCC	3-1-0	4 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites:

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze several key technologies used in manipulating, storing, and analyzing big data.
CO2	Acquire clear understanding of processing data
CO3	Acquire clear understanding of Hadoopmap reduce.
CO4	Categorize and Summarize Big Data and its importance

CO5	Manage Big Data and analyze Big Data
CO6	Apply tools and techniques to analyze Big Data.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit I: Introduction to big data

Big Data and its Importance – Four V’s of Big Data – Drivers for Big Data –Introduction to Big Data Analytics – Big Data Analytics applications. Hadoop’s Parallel World – Data discovery – Open source technology for Big Data Analytics – cloud and Big Data –Predictive Analytics – Mobile Business Intelligence and Big Data – Crowd Sourcing Analytics – Inter- and Trans-Firewall, Analytics - Information Management. (SLE: Predictive Analytics)

Unit II: Processing big data

Integrating disparate data stores - Mapping data to the programming framework Connecting and extracting data from storage - Transforming data for processing - Subdividing data in preparation for Hadoop Map Reduce. (SLE: Data Preparation for Map Reduce)

Unit III: Hadoopmapreduce

Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms -Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows - The Building Blocks of Hadoop Map Reduce - Distinguishing Hadoop daemons - Investigating the Hadoop Distributed File System Selecting appropriate execution modes: local, pseudo-distributed, fully distributed. (SLE: Applications of HadoopMapreduce)

Unit IV: Database Management System

Comparison of File System, Database Management System, Characteristic Features of Database Management Systems, Relational Databases. (SLE: Logical Database Design)

Unit V: Data Base Models

DBMS Languages and Interfaces. Data Base Security and Authorization. (SLE: Data Ware House)

Unit VI: Big data tools and techniques

Installing and Running Pig – Comparison with Databases – Pig Latin – User-Define Functions – Data Processing Operators – Installing and Running Hive – Hive QL – Tables –

Querying Data – User-Defined Functions – Oracle Big Data. (SLE: Installing and Running Hive)

Text Books:

1. Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley, 5th edition, 2009.
2. Michael Minelli, Michehe Chambers, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today’s Business”, 1st Edition, AmbigaDhiraj, Wiely CIO Series, 2013.
3. ArvindSathi, “Big Data Analytics: Disruptive Technologies for Changing the Game”, 1st Edition, IBM Corporation, 2012.
4. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, 1st Edition, Wiley and SAS BusinessSeries, 2012.
5. Tom White, “Hadoop: The Definitive Guide”, 3rd Edition, O’reilly, 2012.

References:

1. Introduction to DBMS – Date C.J, Addison Wesley, 3rd edition, 1981.

Introduction to Mechanical Engineering

ME-XX14A	Introduction to Mechanical Engineering	PEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design simple machine parts and components.
CO2	Understand basic procedure for the selection of machine components
CO3	Design various joints, gears brakes, dynamometer etc.
CO4	Evaluate the modes of failure of various machine components
CO5	Analyze the fatigue and life prediction of mechanical components

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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CO1													
CO2													
CO3													
CO4													
CO5													

Course Contents:

Unit I: Stress and Strains

Concepts of Stress, Strains and theories of failure, Concepts of Fatigue and Creep, Material selection.

Unit II: Design principles

Strength, rigidity and wear considerations, Design for strength, static and dynamic loadings. Manufacturing consideration, limits, fits and standardization.

Unit III: Design of Mechanical Elements

Design of shafts, keys, splines, springs. Design of riveted, bolted, welded and friction joints. Power screws. Theory and principles of design of couplings, clutches, brakes, belt and chain drives, spur, helical, bevel and worm gear drives.

Unit IV: Bearings

Lubrication Systems, Classification of bearings, Design of sliding and rolling contact bearings, Design of journal bearings.

Unit V: Failure analysis of mechanical elements

Quality loss and robust design. Service failure modes, characterization and interpretation. Deformation modes-yielding and creep. Ductile and Brittle fracture

Unit VI: Fatigue failure and design

Fatigue and fracture mechanics approach to design. Cumulative damage – life prediction. Wear- modes and control. Systematic approach to failure analysis.

Text Books / References:

1. Shigley, J.E. and Mitchel, L.D., Mechanical Engineering Design, McGraw-Hill International; 1993.
2. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley and Sons, 1994.
3. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
4. Deutschman, D., Michels, E., Machine Design Theory and Practice, Macmillan, 1992
5. Collens, J.A., “Failure of Materials in Mechanical Design”, John Wiley & Sons, 1991.
6. Fuchs H.O., “Metal fatigue in Engineering”, John Wiley & Sons, 1991.
7. Dieter G.E, “Mechanical Metallurgy (SI Edition), McGraw Hill Book Co., 1988

Introduction to Electronics & Electrical Engineering

ME-XX14B	Introduction to Electronics & Electrical Engineering	PEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	List and explain functioning of basic electronic components
CO2	Explain working of various types of amplifiers
CO3	Analyze various signal conditioning methods
CO4	Understand working of various types of electrical and electronic drives.
CO5	Develop simple circuits using microprocessors and microcontrollers

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit I: Basic Electronics

Diode, Transistor Biasing and Introduction to experimental mode of transistor (Low frequency and high frequency analysis),

Unit II: Amplifiers

Operation amplifiers-Application of operational amplifier characteristics and equivalent circuits, Power amplifier: Class A, Class B, Class C, Class AB efficiency calculation and heat sinks. Feedback amplifiers-Advantages, disadvantages, Classification (positive and negative feedback), V & I feedback.

Unit III: Signal Conditioning

Oscillators-PC phase shift, LC Wein bridge & crystal, Digital- Number system, Boolean algebra, Gates, K-map, sequential circuits, Brief introduction of-Transformer.

Unit IV: Electrical and Electronic Drives

Motors (AC and DC), Solid state devices- SCR, IGBT, Converters & Invertors, Variable speed drives (AC & DC)

Unit V: Sensors and Transducers

Various types of sensors and Transducers, applications of sensors for automation.

Unit VI: Microprocessors and microcontrollers

Introduction to microprocessors and microcontrollers, commonly used microprocessors and microcontrollers, developing simple circuits using commonly used microprocessors and microcontrollers, popular open ware hardwares.

Books:

1. Integrated Electronics Millmanv Halkias Tata McGraw-Hill
2. Digital Design M. Morris Mano McGraw-Hill
3. Operational Amplifier-Linear Integrated Circuits Gayakwad Prentice Hall India
4. Power Electronics Mohammad H. Rasid Prentice Hall India Electrical and Electronics Measurement &
5. Instrumentation A.K. SawhneyhanpatRai& Sons

Simulation, Modeling & Control

ME-XX15A	Simulation, Modeling & Control	Elective II	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Define simulation, its limitations and applications.
CO2	Apply simulation to queuing and inventory situations.
CO3	Acquire knowledge to generate the random numbers for simulation models.
CO4	Analyze the data and verify model of simulation.
CO5	Learn software's and programming languages for developing simulation model.
CO6	Discuss case studies in manufacturing simulation.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2			1								
CO3	2	2	1	2								1
CO4	2	2	1	2						2	1	
CO5	2	2	2	3						1		2
CO6	2						2			1		

Course Contents:

Unit I

Introduction to systems and modeling – discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation.

Unit II

Discrete event simulation and their applications in queueing and inventory problems.

Unit III

Random number generation and their techniques - tests for random numbers. Random variable generation.

Unit IV

Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

Unit V

Simulation languages and packages - FORTRAN, C, C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies.

Unit VI

Simulation of manufacturing and material handling system, Case studies.

Texts / References:

1. Jerry Banks and John S, Carson II “Discrete Event System Simulation”, Prentice Hall, 1984.
2. Geoffrey Gordon., “System Simulation”, Prentice Hall, 1978.
3. Francis Neelamkovil, “Computer Simulation and Modelling”, John Willey and sons, 1987.

Artificial Intelligence & Expert System in Automation

ME-XX15B	Artificial Intelligence & Expert System in Automation	Elective II	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Know the expert system architecture
CO2	Select appropriate AI technique for a given problem
CO3	Develop neural network or fuzzy logic or genetic algorithm for a given situation
CO4	Understand the basics of machine learning
CO5	Apply the principles of machine learning and AI for practical applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit I: Expert system Architecture

Expert system Architecture, knowledge base, inference engine, expert system shell, applications.

Unit II: Fuzzy Logic

Fuzzy sets, membership functions, operation on fuzzy sets; fuzzy control system, Fuzzification, knowledge base, inference, defuzzification, application.

Unit III: Neural Network

Neuron structure, classification, artificial neural network, back propagation training and algorithm, neuro-fuzzy controllers, applications.

Unit IV Genetic algorithms

Concepts, encoding and selection methods, genetic operators (crossover and Mutation), applications.

Unit V Hybrid systems

Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

Unit VI: Artificial intelligence and machine learning:

Definition, knowledge representation techniques, problem solving, search techniques, game playing, knowledge and logic, learning methods, applications of AI.

Text Books / References:

1. Haykin “Neural Networks – A comprehensive Foundation” (Mc-millan)
 2. J.M. Zureda “Introduction to artificial neural networks” (Jaico)
 3. A Cichocki& R Unbehauen “ Neural Networks for optimization and signal Processing” John Wiley
 4. George J. Klin& Tina A Polgar “Fuzzy sets, uncertainty and Information”
 5. BaertKosko “Neural network and fuzzy systems”
 6. Peterson “Introduction to Artificial Intelligence and expert system (PHI)
 7. Michell “Introduction to Genetic Algorithm” (PHI)
 8. Vidyasagar M “Theory of learning and generalization” Springer
 9. S. Rajasekaran, G.A. VijaylakshmiPai “Neural Networks, Fuzzy Logic and Genetic Algorithm”, PHI.
- T.J. Ross: “Fuzzy Logic with Engineering Applications” Second Edition John Wiley India.

Hydraulic, Pneumatic and Fluidic Control

ME-XX15C	Hydraulic, Pneumatic and Fluidic Control	Elective II	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the type of control system and their utility
CO2	Describe the hydraulic power generation
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Discuss steady state operating forces, transient forces and valve instability
CO5	Design of pure fluid digital elements, Lumped and distributed parameter fluid systems

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2				1	1						
CO3	2	2		3	3							
CO4	2					2	3			2		1
CO5	2	2		2	3							

Course Contents

Unit I

Introduction to control system, types of control system and their utility.

Unit II

Hydraulic power generation and transmission, valve control pressure flow relationship and constructions.

Unit III

Steady state operating forces, transient forces and valve instability.

Unit IV

Circuit design, pneumatic valves, hydraulic and pneumatic drives, introduction to fluidic devices and sensors.

Unit V

Lumped and distributed parameter fluid systems, fluid mechanics of jets, wall attachment and vortex devices.

Unit VI

Pure fluidic analog amplifiers, analog signal control techniques, design of pure fluid digital elements.

Texts / References:

1. J.F.Blackburn, G.Rechthof, J.L. Shearer, *Fluid Power Control*, MIT.
2. B.W.Anderson,*The Analysis and Design of Pneumatic Systems*, Wiley.
3. K.Foster, G.Parker, *Fluidic Components and Circuits*, Wiley.
4. A.B.Goodwin, *Fluid Power Systems*, Macmillan.

Process Control & Automation

ME-XX15D	Process Control & Automation	Elective II	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit I: Process Modeling

Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models-Development of empirical models from process data-chemical reactor modeling-. Analysis using softwares

Unit II: Feedback & Feedforward Control

Feedback controllers-PID design, tuning, trouble shooting, Cascade control, Selective control loop, Ratio control.

Unit III: Frequency Response

Control system design based on Frequency response Analysis, Direct digital design, Feed-forward and ratio control. State feedback control. LQR problem, Pole placement.

Unit IV: Software Simulations of control system

Simulation using softwares, Control system instrumentation, Control valves, Codes and standards, Preparation of P& I Diagrams.

Unit V: Advanced process control

Multi-loop and multivariable control, Process Interactions, Singular value analysis, tuning of multi loop PID control systems, decoupling control, strategies for reducing control loop interactions, Real-time optimization.

Unit VI: Plant Control

Model predictive control-Batch Process control-Plant-wide control & monitoring- Plant wide control design- Instrumentation for process monitoring-Statistical process control-Introduction to Fuzzy Logic in Process Control-Introduction to OPC.
Introduction to environmental issues and sustainable development relating to process industries. Comparison of performance different types of control with examples on softwares

References

1. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley , 2004
2. Johnson D Curtis, Instrumentation Technology, (7th Edition) Prentice Hall India, 2002.
3. Bob Connel, Process Instrumentation Applications Manual, McGrawHill, 1996.
4. Edgar, T.F. & D.M. Himmelblau, Optimization of Chemical Processes, McGrawHill Book Co, 1988.
5. Macari Emir Joe and Michael F Saunders, Environmental Quality Innovative Technologies

Finite Element Methods

MME15E	Finite Element Methods	Elective II	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites:

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basics principle of FE method
CO2	Identify mathematical model for solution of common problems
CO3	Solve structural, thermal problem using FE in 1D Case
CO4	Derive element stiffness matrix by different methods
CO5	Understand the formulation for 2D and 3D case
CO6	Recognize need for and engage in lifelong learning

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	3	3	1		1							1
CO3	2	2	1	2	2				2			1
CO4	3								2			
CO5	3	2										
CO6			1									3

Course Contents:

Unit 1

1-D PROBLEMS: Introduction to structural analysis and FEM, Introduction to approximate solutions and FEM, summary of linear elastic mechanics.

Unit 2

1-D PROBLEMS: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit 3

2-D PROBLEMS: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

Unit 4

2-D PROBLEMS: Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

Unit 5

3-D PROBLEMS: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

Unit 6

3-D PROBLEMS: Discrete Kirchhoff's elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

Texts / References:

1. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley and Sons, second edition, 1981.
2. C.S. Krishnamurti, Finite element method, Tata Mc-Graw Hill Publication.
3. K.J. Bathe, Finite Element Method and Procedures, Prentice hall, 1996.
4. Tirupathi, R., and Chandrupatla, Finite Elements in Engineering, PHI Publication, New Delhi.
5. Bruce Irons and SoharabAhmed, Techniques of Finite Elements, John Wiley and Sons, New York.
6. K.J. Bathe, Finite Element Method, Prentice Hall, 1987.
7. O.P., Gupta, Finite and Boundary Element Methods in Engineering, Oxford and IBH.

Virtual Instrumentation

ME-XX15F	Virtual Instrumentation	Elective II	3-0-0	3 Credits
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Pre-Requisites: None

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks
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Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the need and advantages of virtual instrumentation
CO2	Develop GUI and programs for virtual instrumentation
CO3	Learn the data acquisition process
CO4	Link the hard ware with virtual instrumentation

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Course Contents:**Unit I: Virtual Instrumentation: An introduction**

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, and comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

Unit II: VI Programming Techniques

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Unit III: Data acquisition basics

Introduction to data acquisition on PC, Sampling fundamentals, Input/ Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

Unit IV: VI Interface requirements

Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

Unit V: VI toolsets

Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

TEXTBOOKS

1. LabVIEW Graphical Programming , Gary Johnson, Second edition, McGraw Hill, Newyork, 1997.
2. LabVIEW based Advanced Instrumentation Systems, S. Sumathi and P. Surekha, Spinger.

REFERENCES

1. PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.
- 2.WEB RESOURCES: www.ni.com.
- 3.LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 1997.

Communication Skills

BHS16	Communication Skills	HSSC	2-0-0	2 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

UNIT 1

Introduction to communication, Necessity of communication skills, Features of good communication, Speaking skills, Feedback & questioning technique, Objectivity in argument

UNIT 2

Verbal and Non-verbal Communication, Use and importance of non-verbal communication while using a language, Study of different pictorial expressions of non-verbal communication and their analysis

UNIT 3

Academic writing, Different types of academic writing, Writing Assignments and Research Papers, Writing dissertations and project reports

UNIT 4

Presentation Skills: Designing an effective Presentation, Contents, appearance, themes in a presentation, Tone and Language in a presentation, Role and Importance of different tools for effective presentation

UNIT 5

Motivation/Inspiration: Ability to shape and direct working methods according to self-defined criteria Ability to think for oneself, Apply oneself to a task independently with self-motivation, Motivation techniques: Motivation techniques based on needs and field situations

UNIT 6

Self Management, Self Evaluation, Self discipline, Self criticism, Recognition of one's own limits and deficiencies, dependency, etc.
Self Awareness, Identifying one's strengths and weaknesses, Planning and Goal setting, Managing self- emotions, ego, pride, Leadership and Team Dynamics

Reference Books:

1. Mitra, Barun, *Personality Development and Soft Skills*, Oxford University Press, 2016
2. Ramesh, Gopalswamy, *The Ace of Soft Skills: Attitude, Communication and Etiquette for Success*, Pearson Education, 2013
3. Covey, Stephen R., *Seven Habits of Highly Effective People: Powerful Lessons in Personal Change*
4. Rosenberg Marshall B., *Nonviolent Communication: A Language of Life*

Automation Engineering Laboratory

ME-XX17	Automation Engineering Laboratory	PCC	0-0-3	2 Credits
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Examination Scheme:

Practical	
Internal Assessment: 25 Marks	External Exam: 25 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

At least six of the following experiments should be conducted on the appropriate hardware

1. Design and construct a sequential pneumatic circuit using two cylinders
2. Design and construct a sequential pneumatic circuit using three cylinders
3. Design meter-in and meter-out hydraulic circuit
4. Design and construct a sequential electro-pneumatic circuit using minimum two cylinders
5. Design and construct a sequential electro-pneumatic circuit using different type of electric interlocks.
6. Demonstrate the working of stepper motor
7. Demonstrate the working of servo motor
8. Control of servo/stepper motor using micro-controllers
9. Demonstrate working of various types of sensors.
10. Design pneumatic/hydraulic circuits using interlocks through various sensors
11. Design various types of circuits using ladder logic of PLCs

Semester-II
Drives and Control System for Automation

ME-XX21	Drives and Control System for Automation	PCC	3-1-0	4 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	To understand working principles of various types of motors, differences, characteristics and selection criteria.
CO2	To apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications
CO3	To explain control methods of special drives
CO4	To elucidate various linear and rotary motion principles and methods and use the same to application areas
CO5	To carry out programming using PLC and use of various PLCs to Automation problems in industries.
CO6	To discuss supervisory control and data acquisition method and use the same in complex automation areas
CO7	To understand and use logical elements and use of Human Machine Interfacing devices to

Mapping of course outcomes with program outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												
CO7												

Course Contents:

Unit I: Introduction

Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle, , V/F control, Flux Vector control. (SLE: Current control (sensor less vector control))

Unit II: Industrials Drives

DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking, rheostatic and regenerative braking principles in power converters. (SLE: The Hydraulic Motor)

Unit III: Motion laws for rotary and linear systems

Converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing, and control approaches of Robots, Control loops using Current amplifier. (SLE:control loops Using Voltage Amplifier.)

Unit IV: Introduction to Programmable Logic Controllers

Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller (case study) Centralized concept. (SLE: types of field bus systems)

Unit V: Logic, instructions & Application of PLC

What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung.

Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction, Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI's, and Interfacing of HMI with controllers. (SLE: Programming of HMI and its implementation)

Unit VI: Supervisory control & data Acquisitions

Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process field bus), Bit bus. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC based Controller / HMI, (SLE: Case study & implementation for different examples.)

Text Books:

1. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition
2. Andrew Parr, Industrial drives, Butterworth – Heineamann
3. G.K.Dubey.Fundamentals of electrical drives
4. Programmable Logic Controllers by W.Bolton

References:

1. Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5
2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
3. A.E. Fitzgerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition
4. S.K.Pillai. A First course on electric drives –Wiley Eastern 1990
5. Programmable Logic Controllers by Hugh Jack.

Sensors, microprocessors, microcontrollers and their Applications

ME-XX22	Sensors, microprocessors, microcontrollers and their Applications	PCC	3-1-0	4 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the Course the student will be able to:

CO1	Understand the general principles of sensors and transducers
CO2	List and explain the principle and working of various types of sensors
CO3	Understand the requirements for networking of sensors
CO4	Understand the architecture of popular microprocessors and microcontrollers.
CO5	Develop simple circuits using popular microprocessors and microcontrollers

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit I: Fundamentals of Sensors and Transducers Performance

terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter.

Sensors and their applications

Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors.

Unit II: Advanced Sensor Technologies

Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electromagnetic identifier, optical encoders, color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for optoelectronic colour sensor in manufacturing.

Sensors in Flexible Manufacturing Systems: Vision sensors, image transformations, robotvisual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing

Unit III: Networking

Networking of sensors, control of manufacturing process, tracking- the meantime between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.

Unit IV: Sensors for Special Applications

A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.

Unit V: Microprocessors

Evolution of Microprocessors, General architecture of μP , an overview of 8086/88/architecture minimum/maximum mode configuration. Assembly Language programming in 8086, interrupt structure Programmed I/O, parallel I/O (8255-PPI) serial I/O (8251/8250), RS-232, IEEE bus standard, 8157 DMA controller A/D & D/A conversion, 8253/54 PIT/counters, 8087 Numerical processor and its interfacing with 8086.

Unit VI: Microcontrollers

Introduction to 8051 micro-controller family: Pin description of 8051 and its internal structure, connections of I/O ports and Memory organization Addressing mode. Instruction set & its format and simple programs. Atmel micro-controller 89C51 and 89C2051.

Introduction to 8096/8097 family and essential difference with 8051.

Applications of microprocessors and micro-controller

Text Books:

1. Sabnesoloman, sensors & control systems in manufacturing. Mc-Graw Hill book Company Network, 1994.
2. Mechatronics by W, Bolton
3. D V Hall, Microprocessor and It's Applications, TMH.
4. B.B. Bray, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium pro processor, architecture, programming and interfacing, PHI India.
5. Mohammed Refiguzzaman, Microprocessor & Microcomputer Based System Design, Universal Books Stall, New Delhi.
6. Ajay V. Deshmukh "Micro-controllers Theory and Applications." Tata – McGraw Hill companies – 2005.

References:

1. Sensor Technology Handbook by Jon S. Wilson
2. N.L.Buck&T.G.Buckwith, Mechanical measurement.
3. Sensors and Transducers by Ian Sinclair

Numerical Methods & Computational Techniques

MMECH23A	Numerical Methods & Computational Techniques	Elective III	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks

End Term: 60 Marks	
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Pre-Requisites: None

Course Outcomes: At the end of the course, student should be able to:

CO1	Solve a set of algebraic equations representing steady state models formed in engineering Problems
CO2	Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables
CO3	Predict the system dynamic behavior through solution of ODEs modeling the system
CO4	Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.
CO5	Demonstrate proficiency of using MATLAB,VB,ANSYS,EES etc.,

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	1									
CO2			1									
CO3	1					1						
CO4		1		2								
CO5		1		1								
CO6		2	1	3								2

Course Contents:

Unit I

Introduction to Numerical Analysis: Objectives, Mathematical Modeling, Programming Concepts, MATLAB, Computational Accuracy, Precision, Truncation Errors, Taylor Series [~4 hours]

Curve fitting and Regression, Interpolation, Fourier Series concepts [~3 hours]

Unit II

Roots of equations: Bisection, False position, Fixed Point Iteration, Newton-Raphson, Secant methods, Roots of polynomials [~3 hours]

Linear Algebraic Equations, Gauss Elimination [~2 hours]

Unit III

Non-linear Systems of Equations, Gauss-Jordan, LU Decomposition and Matrix Inversion, Gauss-Seidel, Optimization concepts [~5 hours]

Unit IV

Numerical Integration: Trapezoidal and Simpson’s Rules, Gaussian Quadrature [~3 hours]
 Numerical Differentiation and finite-difference approximations [~2 hours]

Unit V

Ordinary Differential Equations: Euler’s and Runge-Kutta Methods, Boundary-Value, Eigen value and Eigen vector Problems [~4 hours]

Unit VI

Partial Differential Equations: Elliptic Equations, Laplace Equation and Boundary Conditions, Control Volume Approach, Parabolic Equations, Explicit and Implicit Methods, Crank-Nicolson, Introduction to Finite Element Methods [~4 hours]

TEXTS / REFERENCES:

1. Steven C. Chapra and Raymond P. Canale, Numerical Method for Engineers, 6th Edition, McGraw-Hill, 2010.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th Edition, PHI Learning, 2012
3. S. P. Venkateshan, Computational Methods in Engineering, 1st Edition, Academic Press, 2013
4. S.K. Gupta, Numerical Methods for Engineers, New Age International, 2009
5. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge, 2007
6. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, Wiley-India, 2004.
7. J. D. Hoffman and Steven Frankel, Numerical Methods for Engineers and Scientists, 2nd Edition, McGraw-Hill, 2001 S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edition, McGraw-Hill, 1980.

CAD-CAE

ME-XX23B	CAD-CAE	Elective III	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Course Pre-requisites: Numerical Methods & Computational Techniques (PC3), Structured or Object Oriented Programming (FORTRAN / C / C++ / Java / VB)

Course Outcomes: At the end of the course, student should be able to:

CO1	Demonstrate - Polynomial and spline interpolation, Bezier curves, B-spline to surfaces representation, patches and composite surfaces.
CO2	Design and create Solid model assembly of thermal and fluid engineering system in CAD software.
CO3	Analyse simple Engineering problem by selecting appropriate Mesh generation.
CO4	Modeling and Meshing of Thermal and Fluid Flow equipment in CAD.
CO5	Simulate and demonstrate Thermal and Fluid systems by using ANSYS, EES, MATLAB etc.
CO6	Understand and simulate computer aided manufacturing.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		1		1	1							
CO3		2		1								
CO4	1	1		1								
CO5	1	1		3								
CO6	1	1										

Course Contents:

Unit I

Overview of CAD Applications, Curves - Polynomial and spline interpolation, Bezier curves, B-splines, Introduction to surfaces representation, patches and composite surfaces [~3 hours]
 Solid Modeling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Solid modeling operations [~3 hours]

Unit II

Computer Graphics: Mathematical principles for 2D and 3D visualization, Matrix transformations, Modeling, viewing, projection and rendering, OpenGL graphics library [~3 hours]
 Meshing – Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria [~2 hours]

Unit III

CAD data formats and exchange [~1 hour]
 Hands-on lab sessions: Modeling and Meshing of Thermal and Fluid Flow equipment [~6 hours]

Unit IV

Computer Aided Engineering: Lab simulations for Thermal and Heat Transfer [~3 hours]

Unit V

Computational Fluid Dynamics: Lab simulations for Fluid Flow [~3 hours]

Unit VI

Computer Aided Manufacturing - CAD/CAM data exchange, CAD/CAM integration,

Texts / References:

1. Grover, M.P., Zeemer, CAD/CAM/CIM, Prentice Hall, India
2. Reddy J. N., Introduction to Finite Element Methods, McGraw Hill Education; 3 edition
3. I. Zeid, Mastering CAD/CAM, McGraw Hill Education; 2 edition

Flexible Manufacturing Systems

MCADM23C	Flexible Manufacturing Systems	Elective III	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None**Course Outcomes:** At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Detailed Syllabus:

Unit I: Introduction

FMS definition and classification of manufacturing systems, automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

Unit II: Economic Analysis

Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS.

Unit III: FMS Equipment

Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Unit IV: Group Technology

GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part-machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular Vs FMS production.

Unit V: Plant layout, FMS and GT layouts

FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system,

Unit VI: Communication networks

FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems. Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control. FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

Books:

1. Automation, Production System & Computer Integrated Manufacturing Groover Englewood
2. Design and Operation of SMS Rankey IFS
3. Flexible Manufacturing System Wernecks Spring-Verlag
4. FMS in Practice Bonctto Northox Ford
5. Flexible Manufacturing Cells and systems W.W. Luggen Prentice Hall India
6. Performance Modelling of Automated Manufacturing Vishwanathan & NaraharPrentice Hall India.

Machine Vision

ME-XX23D	Machine Vision	Elective III	3-0-0	3 Credits
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Examination Scheme:

Theory

Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	To understand the concepts of image functions distribution and convolution.
CO2	To understand different concepts of segmentation and models of strategies.
CO3	To adept to growing semantic region and genetic image interpretation.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1												
CO2												
CO3												

Course Contents:

Unit I: Image capture and digitization

Image transforms; digital Fourier transform, fast Fourier transform, other transforms, convolution, correlation; image enhancement; spatial methods, frequency domain methods; image restoration;

Unit II: Geometric transformation

Image compression; error free and lossy compression; edge detection; hough transform, region based segmentation; image feature/region representation and descriptors; morphological operators;

Unit III: Features based matching

Baye’s classification; Low level vision: Introduction to stereopsis, shape from shading, optical flow; Rule based picture segmentation. Development and evaluation of image algorithms.

Unit IV: Image Filtering

Histogram Modification, Linear Systems, Linear Filters, Median Filter, Gaussian Smoothing.

Unit V: EDGE Detection

Gradient, Steps in Edge Detection, Roberts Operator, Sobel Operator, Prewitt Operator, Comparison, Second Derivative Operators, Laplacian of Gaussian, Image Approximation, Gaussian Edge Detection, Canny Edge Detector, Subpixel Location Estimation, Edge Detector Performance, Sequential Methods, Line Detection

Unit VI: Object Detection

System Components, Complexity of Object Recognition, Object Representation, Observer-Centered Representations, Object-Centered Representations, Feature Detection, Recognition Strategies, Verification.

Text Books / References:

1. Milan Sanka, Vaclav Halavac, Roger Boyle “Image Processing, analysis and machine vision” Vikas Publishing.
2. Kenneth & Castleman “Digital Image Processing (PHI)
3. Conzalez RC & P Wint “Digital Image Processing” Addison Wesley
4. Chanda & Mazumdar “ Digital Image Processing & Analysis” (PHI)
5. Anil K. Jain, “Digital Image Processing”, Prentice Hall, 1989

Mechatronics

ME-XX24A	Mechatronics	Elective IV	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Course Outcomes: At the end of the course, the student will be able to:

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Write a PLC program using Ladder logic for a given application
CO5	Understand applications of microprocessor and micro controller
CO6	Analyze PI, PD and PID controllers for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1

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

Course Contents:

Unit 1

Introduction to Mechatronic systems, elements, advantages and practical examples of Mechatronic systems.

Sensors and Transducers:

Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2

Signal Conditioning and Data Representation: Types of electronic signals, need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3

Electrical Drives: Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

Pneumatics and Hydraulics

Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods. Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4

Microprocessor and Microcontroller

8085 microprocessor, architecture, various types of registers and their functions in 8085 μ P, Instruction sets, interfacing, applications.8081 microcontroller, architecture, Instruction sets, various pins and their functions interfacing, applications.

Programmable Logic Controller

Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

Unit 5

Control Systems

Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using spring, Dashpot and Masse quivalence.

Unit 6

Stability of Systems

On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

Texts / References:

1. HMT Limited, Mechatronics, Tata McGraw-Hill, 1998.
2. Bolton, W., Mechatronics; Electronic Control System in Mechanical Engineering, Pearson Education Asia, 1999.
3. Raven, Automatic Control Engineering, McGraw Hill, New York, 1986

Design for Mechanisms and Manipulators

MCADM24B	Design for Mechanisms and Manipulators	Elective IV	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit I: Kinematics

Mobility analysis, Degree of Freedom (DOF), Mixed Mobility, Total, Partial and Fractional DOF, Closed and Open Chain Systems, Application of D-H representation for 1) Kinematic parameter tables for standard robot structures.

Unit II: Link coordinate diagram and arm matrix

Link coordinate diagram and arm matrix of SCARA, Alpha II, PUMA articulated robot, standard robot, polar frame, structure robot, Enter transform solution, Arm matrix of standard Robots, Polar frame, structure robots

Unit III: Structural Analysis and Synthesis of mechanisms

Structural Analysis and Synthesis of mechanisms, Alternative design solutions; Coding, evaluation and selection of optimum mechanism. Type synthesis, number synthesis and design of mechanisms. 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

Classifications, actuation and transmission systems; Coordinate Transformation – DH notations, Inverse and Forward kinematics, Manipulator dynamics from Lagrangian and Newtonian point of view.

Unit V: Dynamic Analysis of manipulator

Forces in Manipulator, manipulate Dynamics, selecting of robots for Robot Application Reliability of Robotic & Automation systems and their evaluation.

Unit VI: Gripper Design

Linkage activated grippers: kinematic and dynamic design, other principles of gripping like, magnetic grippers, adhesive grippers, internally expanding grippers, mandrels, etc. their static and dynamic analysis.

Text Books / References:

1. Andeen, G.B., “Robort Design Hand Book”, SRI International, McGraw Hill,
2. Craig, J.J., “Introduction to Robotics”, Mechanics and Control, Addison Wesley
3. Spong, M., and Vidyasagar, M. “Robot Dynamics and Control”, John Wiley, NY, 1989.
4. Venkataraman. S.T., and liberall. T., “Dextrous Robot Hands”, S
5. AppuKuttan, “Robotics”, I.K. International Publishing house

Metrology and Computer Aided Inspection

MME24C	Metrology and Computer Aided Inspection	Elective IV	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain high precision measurement requirements of industry and select instruments for high precision.
CO2	Using various measuring standards and instruments for different applications.
CO3	Calibrate basic metrology instruments used in machine shop, and Identify techniques to minimize the errors in measurement.
CO4	Employing limits and design gauges
CO5	Explain the different instruments used for linear and angular measurements, surface finish and form features of a component
CO6	Identify the advanced measurement principles with ease and operate sophisticated measurement machines.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1			2	2						1
CO2	2	1	3	1	1	1						
CO3	2	2		3								2
CO4	2	2	2		3							2
CO5		1	1		1							1
CO6						3						2

Course Contents:

Unit 1

- Metrological concepts, Abbe's principle, need for high precision measurements, problems associated with high precision measurements.

Unit 2

- Standards for length measurement, shop floor standards and their calibration, light interference, method of coincidence.

Unit 3

- Slip gauge calibration, measurement errors, various tolerances, and their specifications, gauging principles.

Unit 4

- Selective assembly, comparators, angular measurements, principles and instruments, gear and thread measurements.

Unit 5

- Surface and form metrology, computer aided metrology, principles and interfacing, software metrology, laser metrology, CMM, types, probes used applications.

Unit 6

- Non-contact CMM using electro-optical sensors for dimensional metrology, non-contact sensors for surface finish measurements, image processing and its applications in metrology.

TEXTS / REFERENCES:

1. D.J.Whitehouse, *Handbook of Surface Metrology*, Inst. of Physics Bristol and Philadelphia, 1994.
2. R.K.Jain, *Engineering Metrology*, Khanna Publishers, 2000.
3. Galleyer and Shotbolt, *Metrology for Engineers*, ELBS, 1998.

Research Methodology

MOE25A	Research Methodology	OEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Course Outcomes: At the end of the course, student should be able to

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

PO's →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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CO's↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution, 2- Means medium contribution, 3- Maximum contribution

Course Contents:

Unit 1

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit 2

Research process – Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit 3

Hypothetical proposals for future development and testing, selection of Research task.

Unit 4

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit 5

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

Texts/References

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Design of Experiments

MOE25B	Design of Experiments	OEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	1	1		1	1	1	1	1		1	1	1
CO2	3	2	1	3	2	1	2	1	1	2	1	1
CO3	3	2	1	3	2	1	2	1	1	2	1	1
CO4	3	3	1	3	2	1	2	1	1	2	1	1
CO5	2	3	1	2	3	2	2	1	1	2	1	1

Course Contents:

Unit 1

Introduction: Modern quality control, quality in engineering design, history of quality engineering.

The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-line quality control, Taguchi's quality philosophy.

Unit 2

Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of

estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

Unit 3

Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over an sixteen run experimental design, blocking two level designs, other two level designs.

Unit 4

Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.

Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

Unit 5

Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels. Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance.

Unit 6

Computer Software for Experimental Design: Role of computer software in experimental design, summary of statistical packages, example of use of software packages. Using Experiments to improve Processes: Engineering design and quality improvement, steps to implementing use of engineering design.

Texts/References:

1. D.C. Montgomery, Design and Analysis of Experiments, 5th Edition, John Wiley and Sons, NewYork, 2004.
2. R.H. Lochner and J.E. Matar, Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design, Chapman and Hall, London, 1983.

Advanced Optimization Techniques

MOE25C	Advanced Optimization Techniques	OEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Prerequisite: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Enables to acquire mathematical methods and apply in engineering disciplines.
CO2	Apply methods of optimization to solve a linear, non-linear programming problem by various methods
CO3	Optimize engineering problem of nonlinear-programming with/without constraints, by using this techniques
CO4	Use of dynamic programming problem in controlling in industrial managements.
CO5	Simulate Thermal engineering system problem. Understand integer programming and stochastic programming to evaluate advanced optimization techniques.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1		1		1
CO2	2	1	1					1				
CO3		2							1			
CO4	1				2	1				2		1
CO5			1	2	1	1	2		1	2		1

Course Contents:

Unit 1

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

Unit 2

MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method –Univariant Method – pattern search methods – Powell’s – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method.

Variable metric method.

Unit 3

GEOMETRIC PROGRAMMING: Polynomials – arithmetic – geometric inequality – unconstrained G.P– constrained G.P

DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

Unit 4

LINEAR PROGRAMMING: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.

Simulation: Introduction – Types – Steps – application – inventory – queuing – thermal system.

Unit 5

INTEGER PROGRAMMING: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables Distributions – mean, variance, Correlation, co variance, joint probability distribution stochastic linear, dynamic programming.

TEXTS/REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia

Environmental Engineering and Pollution Control

MOE25D	Environmental Engineering and Pollution Control	PEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Course Objectives:

1. To Understand the need of pollution control, its impact, control
2. To familiarize the students about the pollution control techniques
3. To carry out the real life problem

Course Outcomes:

At the end of the program the student will be able to:

CO1	Identify effects of industrialization on environmental pollution in various field.
CO2	Describe photochemical smog, acid Rain, Greenhouse effect, ozone depletion, global warming.
CO3	Suggest pollution control techniques for vehicles, refrigeration, industries, chemical and power plant.
CO4	Do Case study on any industry and analyze carbon exertion rate, water pollution, soil pollution etc.
CO5	Design pollution control devices for vehicle, analyze and find out replacement CFC refrigerant with HC refrigerant.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	2											1
CO3				1			2	1				1
CO4	2					2			1			
CO5						1						2

Course Content

Unit I

Impact of industrialization and modernization - pollution and pollutants. Air pollution and its effects - air pollution - sources - pollutants – organic and inorganic pollutants - gaseous pollutants– nitrogen oxides - particulate pollutants - effect of pollutants on plants – animals and human beings.

Unit II

photochemical oxidants - photochemical smog – acid Rain - Green house effect - ozone depletion - global warming -Environmental pollution techniques for air pollution - monitoring and Control measures of air pollution - dust control equipment - Electrostatic precipitators and scrubbers.

Unit III

Water pollution and its effects structure - water pollution - sources -Pollutants - industrial effluents - domestic wastes - agrochemicals -Heavy metals - effect of pollutants on plants - animals and human beings Bod - eutrophication - waste water treatment - indicator orgnisms -Oxidation pond - water pollution analysis and monitoring – drinking Water standards. Soil pollution and its effects - soil pollution - sources - solid waste Disposal and their effects - pesticides - types and effect of pollutants on Plants - animals and human beings - biomagnification - fertilizers and its Effect of pollutants on plants - animals and human beings –

UNIT IV

soil pollution Control measures - soil microbes and function - biofertilizer. Noise pollution and its effects - noise pollution - sources – noise Exposure level and standards - impacts - noise control and abatement Measures.

Unit V

Marine pollution - sources and control of marine pollution – criteria Employed for disposal of pollutants in marine system – coastal Management. Radioactive pollution and its impacts - radioactive - sources - effect of Pollutants of plants - animals and human beings - prevention and control Measures of radioactive pollution.

Unit VI

Assessment and control of pollution - environmental standards - Assessment of pollution effects due to air - water - soil and radioactive Pollution - biotechnology in pollution control - microbial role in Pollution control - biomonitoring and bioremediation - pollution control Legislations for air - water - land etc. Biotechnology in pollution control - bioremediation (organic and Inorganic pollutants) - bioleaching and biomineralization.

Text/References

1. Environmental Pollution Analysis:Khopkar.
2. Environmental Science – A study of Inter relationships, E. D. Enger, B. E. Smith, 5th ed., W C B publication.
3. Environmental Pollution Control Engineering: C. S. Rao
4. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
5. J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.

Soft Computing Techniques

MOE25E	Soft Computing Techniques	OEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Course Outcomes: At the end of the course, student should be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

PO's → CO's↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution, 2- Means medium contribution, 3- Maximum contribution

Course Contents:

Unit 1

INTRODUCTION

Soft Computing: Introduction of soft computing, Evolutionary Algorithms vs. Conventional optimization techniques, various types of soft computing techniques, applications of soft computing.

Artificial Intelligence: Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Propositional and predicate logic, monotonic and non-monotonic reasoning, forward Reasoning, backward reasoning.

Unit 2

OPTIMIZATION CONCEPTS

Objective functions, constraints, Search space, local optima, global optima, fitness functions, search techniques, etc.

Unit 3

NEURAL NETWORKS

Artificial neural network: Introduction, characteristics- learning methods – taxonomy – Evolution of neural networks- basic models – important technologies – applications.

McCulloch-Pitts neuron – linear separability – hebb network – supervised learning network: perceptron networks – adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network – unsupervised learning networks: Kohonenself organizing feature maps, LVQ – CP networks, ART network.

Unit 4

FUZZY LOGIC

Fuzzy logic: Introduction – crisp sets- fuzzy sets – crisp relations and fuzzy relations: cartesian product of relation – classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets.

Membership functions: features, fuzzification, methods of membership value assignments- Defuzzification: lambda cuts – methods – fuzzy arithmetic and fuzzy measures: fuzzy arithmetic – extension principle – fuzzy measures – measures of fuzziness -fuzzy integrals – fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making.

Unit 5

GENETIC ALGORITHM

Genetic algorithm- Introduction – biological background – traditional optimization and search techniques – Genetic basic concepts.

Genetic algorithm and search space – general genetic algorithm – operators – Generational cycle – stopping condition – constraints – classification genetic programming – multilevel optimization – real life problem- advances in GA.

Unit 6

HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS

Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

Texts/References

1. J. S. R. Jang, C.T. Sun and E. Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI /Pearson Education 2004.
2. S. N. Sivanandam and S. N. Deepa, “Principles of Soft Computing”, Wiley India Pvt Ltd, 2011.
3. S. Rajasekaran and G. A. VijayalakshmiPai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications”, Prentice-Hall of India Pvt. Ltd., 2006.
4. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.
5. David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.
6. James A. Freeman, David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 1991.
7. Simon Haykin, “Neural Networks Comprehensive Foundation” Second Edition, Pearson Education, 2005.

Manufacturing Automation

MOE25F	Manufacturing Automation	OEC	3-0-0	3 Credits
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Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concept of automation and human factors
CO2	Designing a Pneumatic and Hydraulic system for a given application
CO3	Demonstrate the use of different sensors for automation
CO4	Design automation systems for a given application
CO5	Understand the circuit optimization techniques

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I

Product cycle, manufacturing functions, types of automation, degree of automation, technical, economic and human factors in automation.

Unit II

Technologies- mechanical, electrical, hydraulic, pneumatic, electronic, hybrid systems, comparative evaluation.

Unit III

Development of small automation systems using mechanical devices, synthesis of hydraulic circuits.

Unit IV

Circuit optimization techniques, illustrative examples of the above types of systems.

Unit V

Industrial logic control systems logic diagramming, programmable controllers.

Unit VI

Applications, designing for automation, cost-benefit analysis.

TEXTS / REFERENCES:

1. A.N.Gavrilov, *Automation and Mechanization of Production Processes in Instrument Industry*, Pergaman Press, Oxford, 1967.
2. G.Pippenger, *Industrial Hydraulics*, MGH, New York, 1979.
3. F.Kay, *Pneumatics for Industry*, The Machining Publishing Co., London, 1969.
4. A. Ray, *Robots and Manufacturing Assembly*, Marcel Dekker, New York, 1982.

Seminar

ME-XX26	Seminar	PCC	0-0-4	2 Credits
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Examination Scheme:

Practical	
Internal Assessment: 25 Marks	External Exam: 25 Marks

Pre-Requisites: Previously studied course subjects.

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well organized report employing elements of technical writing and critical thinking.
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		1	2		2	2	2	1	2
CO2		2				2		1	2	1		1
CO3						1	1	2	2	2		2
CO4	1	2	1	1		1	1	1	2	1		1

Objective:

To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self-confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Manufacturing Systems Management related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a manufacturing organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Mini Project

ME-XX27	Mini Project	PCC	0-0-4	2 Credits
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Examination Scheme:

Practical	
Internal Assessment: 25 Marks	External Exam: 25 Marks

Pre-Requisites: Previously studied course subjects.

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

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

Objectives:

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities.

Individual students are required to choose a topic of their interest. The subject content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organisations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.

Attendance, regularity of student (20 marks)

Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

Report = 25 marks

Concept/knowledge in the topic = 15 marks

Presentation = 10 marks

Total marks = 50 marks

**Semester-III
Project Management**

MMECH31	Project Management	PCC	0-0-0	2 Credits
Continuous Assessment 50 Marks		PR/OR 50 Marks	Total 100 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit-1

- Introduction to Project management: Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.

Unit-2

- Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

Unit-3

- Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.

TEXT BOOKS/REFERENCES:

1. Shtub, Bard and Globerson, Project Management: Engineering, Technology, and Implementation, Prentice Hall, India
2. Lock, Gower, Project Management Handbook.

Intellectual Property Rights

MMECH32	Intellectual Property Rights	PCC	0-0-0	2 Credits
Continuous Assessment 50 Marks		PR/OR 50 Marks	Total 100 Marks	

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Enumerate and demonstrate fundamental terms such as copy-rights ,Patents ,Trademarks etc.,
CO2	Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.
CO3	exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
CO4	Develop awareness at all levels (research and innovation) of society to develop patentable technologies.
CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property audits
CO6	Manage and safeguard the intellectual property and protect it against unauthorized use

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1					1		1			
CO2	1		2				1		2			2
CO3						1		1				
CO4						1			1			
CO5			1						1			1
CO6												

Course Contents:

Unit-1

- Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement ;searching & filing; Utility Models an introduction;

Unit-2

- Copyrights ; their definition; granting; infringement ;searching & filing, distinction between related and copy rights; Trademarks ,role in commerce ,importance , protection, registration; domain names;

Unit-3

- Industrial Designs ; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications , international protection; Plant

varieties; breeder's rights, protection; biotechnology& research and rights managements; licensing, commercialization; ; legal issues, enforcement ;Case studies in IPR.

TEXT BOOKS/REFERENCES:

1. Prabuddha Ganguli, IPR: Unleashing the Knowledge Economy, published by Tata McGraw Hill 2001.

Project Stage - I

ME-XX33	Project Stage -I	PCC	0-0-0	10 Credits
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Examination Scheme:

Internal Assessment: 50 Marks	External Exam: 50 Marks
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Pre-Requisites: Previously studied course subjects.

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

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

Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from manufacturing organisations. The topic should be on Manufacturing Systems Management or any of the topics related with Manufacturing stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area

of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4th semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Semester IV
Project Stage-II

ME-XX41	Project Stage-II	PCC	0-0-0	20 Credits
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Examination Scheme:

Internal Assessment: 100 Marks	External Exam: 100 Marks
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Pre-Requisites: Previously studied course subjects.

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

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

Objectives:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be

prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.